21 Radio Electronics FactCard

Capacitor Codes

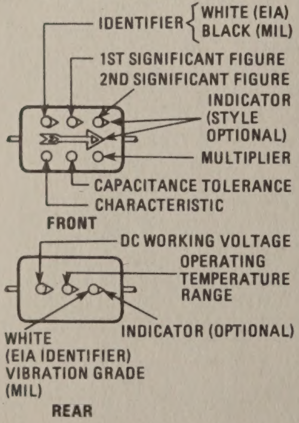
Color Code for Molded Mica Capacitors

Color	Capacitance		Capacitance Tolerance	DC Working Voltage	Operating Temperature Range	Vibration Grade (MIL)
	1st and 2nd Significant Figures	Multiplier				
Black	0	1	±20% (EIA)		−55° to +70°C (MIL)	10-55 Hz
Brown	1	10	±1%	100 (EIA)		
Red	2	100	±2%		−55° to + 85°C	
Orange	3	1000		300		
Yellow	4	10,000 (EIA)			−55° to +125°C	10-2000 Hz
Green	5		±5%	500		
Blue	6				−55° to +150°C (MIL)	
Purple (violet)	7					
Gray	8					
White	9					
Gold		0.1	±½% (EIA)	1000 (EIA)		
Silver		0.01 (EIA)	±10%			

21 Radio Electronics **FactCard**

Capacitor Codes

COLOR CODE FOR MOLDED MICA CAPACITORS



CAPACITOR CHARACTERISTIC CODE

Color	Temperature Coefficient (ppm/°C)	Capacitance Drift
Black	±1000	±5% +1 pF
Brown	±500	±3% +1 pF
Red	±200	±0.5%
Orange	±100	±0.3%
Yellow	−20 to +100	±0.1% +0.1 pF
Green	0 to +70	±0.05% +0.1 pF

EIA TEMPERATURE CHARACTERISTIC CODE FOR DISC CERAMIC CAPACITORS

Minimum Temperature		Maximum Temperature		Max. Cap. Change Over Temp. Range	
X	−55°C	2	+45°C	A	±1.0%
Y	−30°C	4	+65°C	B	±1.5%
Z	+10°C	5	+85°C	C	±2.2%
		6	+105°C	D	±3.3%
		7	+125°C	E	±4.7%
				F	±7.5%
				P	±10%
				R	±15%
				S	±22%
				T	−33%, +22%
				U	−56%, +22%
				V	−82%, +22%

21 Radio Electronics FactCard

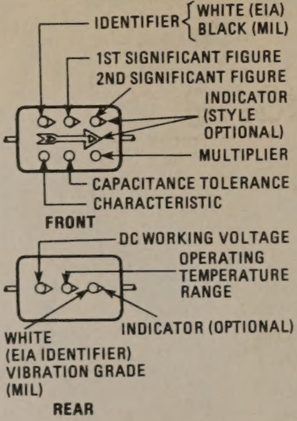
Capacitor Codes

Color Code for Molded Mica Capacitors

Color	Capacitance		Capacitance Tolerance	DC Working Voltage	Operating Temperature Range	Vibration Grade (MIL)
	1st and 2nd Significant Figures	Multiplier				
Black	0	1	±20% (EIA)		−55° to +70°C (MIL)	10-55 Hz
Brown	1	10	±1%	100 (EIA)		
Red	2	100	±2%		−55° to + 85°C	
Orange	3	1000	–	300		
Yellow	4	10,000 (EIA)			−55° to +125°C	10-2000 Hz
Green	5		±5%	500		
Blue	6				−55° to +150°C (MIL)	
Purple (violet)	7					
Gray	8					
White	9					
Gold		0.1	±½% (EIA)	1000 (EIA)		
Silver		0.01 (EIA)	±10%			

21 Radio Electronics FactCard Capacitor Codes

COLOR CODE FOR MOLDED MICA CAPACITORS



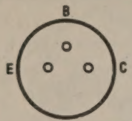
CAPACITOR CHARACTERISTIC CODE

Color	Temperature Coefficient (ppm/°C)	Capacitance Drift
Black	±1000	±5% +1 pF
Brown	±500	±3% +1 pF
Red	±200	±0.5%
Orange	±100	±0.3%
Yellow	−20 to +100	±0.1% +0.1 pF
Green	0 to +70	±0.05% +0.1 pF

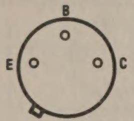
EIA TEMPERATURE CHARACTERISTIC CODE FOR DISC CERAMIC CAPACITORS

Minimum Temperature		Maximum Temperature		Max. Cap. Change Over Temp. Range	
X	−55°C	2	+45°C	A	±1.0%
Y	−30°C	4	+65°C	B	±1.5%
Z	+10°C	5	+85°C	C	±2.2%
		6	+105°C	D	±3.3%
		7	+125°C	E	±4.7%
				F	±7.5%
				P	±10%
				R	±15%
				S	±22%
				T	−33%, +22%
				U	−56%, +22%
				V	−82%, +22%

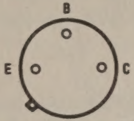
19 Radio Electronics FactCard Transistor Pinouts



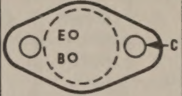
TO-1a



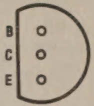
TO-5



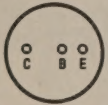
TO-18



TO-66

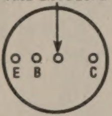


TO-92

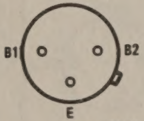


TO-1b

INTERLEAD SHIELD AND ENVELOPE

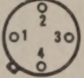


TO-7



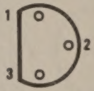
TO-18a

SHIELD LEAD CONNECTED TO CASE



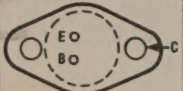
	-	g
1	e	d
2	b	s
3	c	g
4	sh	sh

TO-72

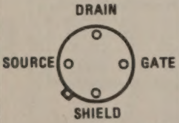


	a	k
1	E	B
2	B	E
3	C	C

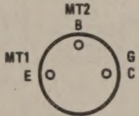
TO-92a



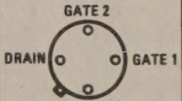
TO-3



TO-12

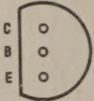


TO-39



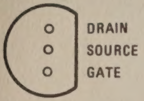
SOURCE AND SUBSTRATE

TO-72f

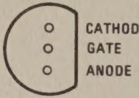


TO-92b

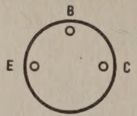
19 Radio Electronics FactCard Transistor Pinouts



TO-92c



TO-92f



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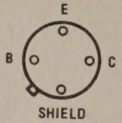
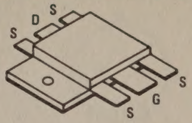
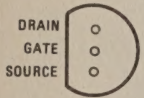


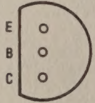
SO-12a



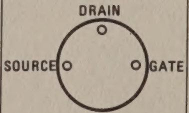
C220



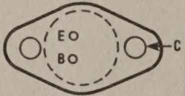
TO-92d



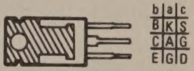
TO-92h



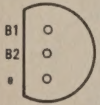
TO-106f



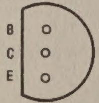
SO-55



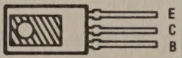
P1
(ALSO PLASTIC TO-66)



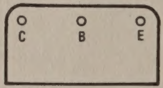
TO-92e



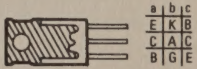
TO-98



TO-126



E-LINE



P3
(ALSO PLASTIC TO-3)

10 Radio Electronics FactCard Wire Table

COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear Inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
1	289.3	83690	—	—	—	.1239	119.6	7.348
2	257.6	66370	—	—	—	.1563	94.8	6.544
3	229.4	52640	—	—	—	.1970	75.2	5.827
4	204.3	41740	—	—	—	.2485	59.6	5.189
5	181.9	33100	—	—	—	.3133	47.3	4.621
6	162.0	26250	—	—	—	.3951	37.5	4.115
7	144.3	20820	—	—	—	.4982	29.7	3.665
8	128.5	16510	7.6	—	7.1	.6282	23.6	3.264
9	114.4	13090	8.6	—	7.8	.7921	18.7	2.906
10	101.9	10380	9.6	9.1	8.9	.9989	14.8	2.588
11	90.7	8234	10.7	—	9.8	1.26	11.8	2.305
12	80.8	6530	12.0	11.3	10.9	1.588	9.33	2.053
13	72.0	5178	13.5	—	12.8	2.003	7.40	1.828
14	64.1	4107	15.0	14.0	13.8	2.525	5.87	1.628
15	57.1	3257	16.8	—	14.7	3.184	4.65	1.450
16	50.8	2583	18.9	17.3	16.4	4.016	3.69	1.291
17	45.3	2048	21.2	—	18.1	5.064	2.93	1.150
18	40.3	1624	23.6	21.2	19.8	6.385	2.32	1.024
19	35.9	1288	26.4	—	21.8	8.051	1.84	.912

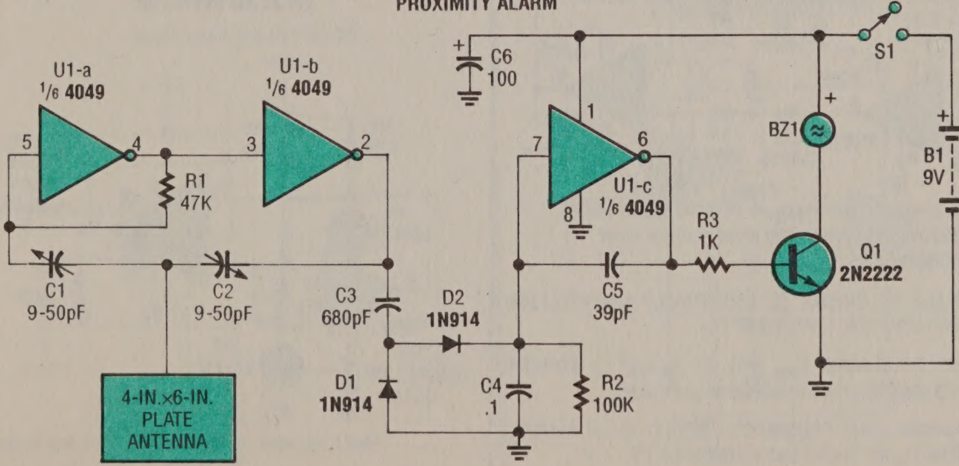
10 Radio Electronics **FactCard**

Wire Table

COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear Inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
20	32.0	1022	29.4	25.8	23.8	10.15	1.46	.812
21	28.5	810	33.1	—	26.0	12.8	1.16	.723
22	25.3	642	37.0	31.3	30.0	16.14	.918	.644
23	22.6	510	41.3	—	37.6	20.36	.728	.573
24	20.1	404	46.3	37.6	35.6	25.67	.577	.511
25	17.9	320	51.7	—	38.6	32.37	.458	.455
26	15.9	254	58.0	46.1	41.8	40.81	.363	.405
27	14.2	202	64.9	—	45.0	51.47	.288	.361
28	12.6	160	72.7	54.6	48.5	64.9	.228	.321
29	11.3	127	81.6	—	51.8	81.83	.181	.286
30	10.0	101	90.5	64.1	55.5	103.2	.144	.255
31	8.9	80	101	—	59.2	130.1	.114	.227
32	8.0	63	113	74.1	61.6	164.1	.090	.202
33	7.1	50	127	—	66.3	206.9	.072	.180
34	6.3	40	143	86.2	70.0	260.9	.057	.160
35	5.6	32	158	—	73.5	329.0	.045	.143
36	5.0	25	175	103.1	77.0	414.8	.036	.127
37	4.5	20	198	—	80.3	523.1	.028	.113
38	4.0	16	224	116.3	83.6	659.6	.022	.101
39	3.5	12	248	—	86.6	831.8	.018	.090

PROXIMITY ALARM



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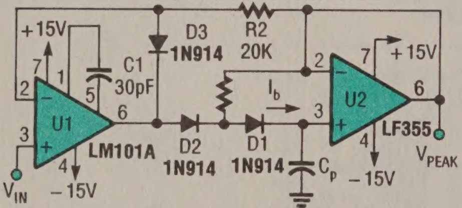
APPLICATIONS CIRCUITS

LOW DRIFT PEAK DETECTOR



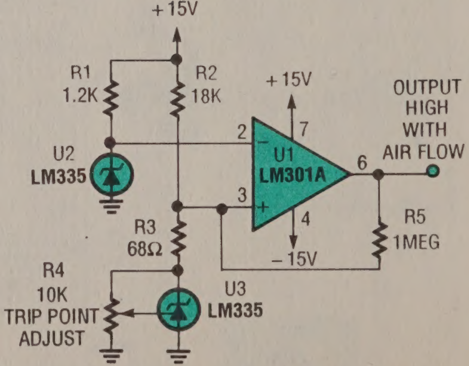
BY ADDING D1 AND R_f, V_{D1}-0 DURING HOLD MODE. LEAKAGE OF D2 PROVIDED BY FEEDBACK PATH THROUGH R_f.

LEAKAGE OF CIRCUIT IS ESSENTIALLY I_b(LF155,LF156) PLUS CAPACITOR LEAKAGE OF Cp.

DIODE D3 CLAMPS V_{OUT} (A1) TO V_{IN}-V_{D3} TO IMPROVE SPEED AND TO LIMIT REVERSE BIAS OF D2.

MAXIMUM INPUT FREQUENCY SHOULD BE << $1/2\pi R_f C_{D2}$ WHERE C_{D2} IS SHUNT CAPACITANCE OF D2.

AIR-FLOW DETECTOR



*SELF HEATING IS USED TO DETECT AIR FLOW

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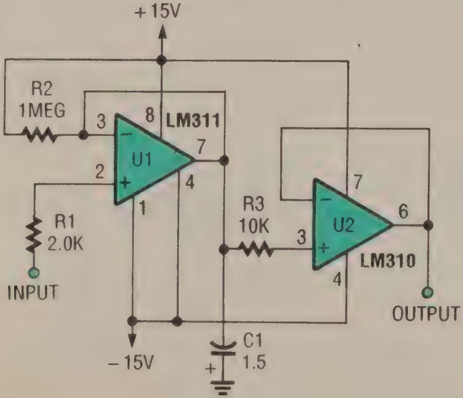
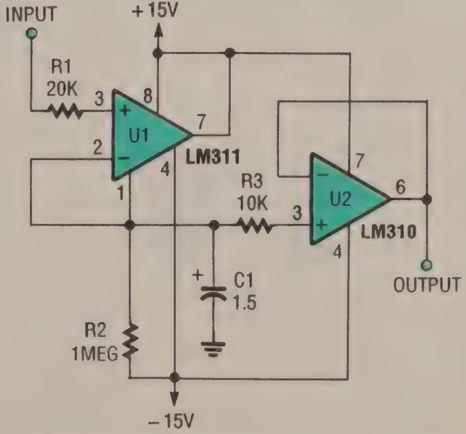
APPLICATIONS CIRCUITS

NEGATIVE PEAK DETECTOR



POSITIVE PEAK DETECTOR



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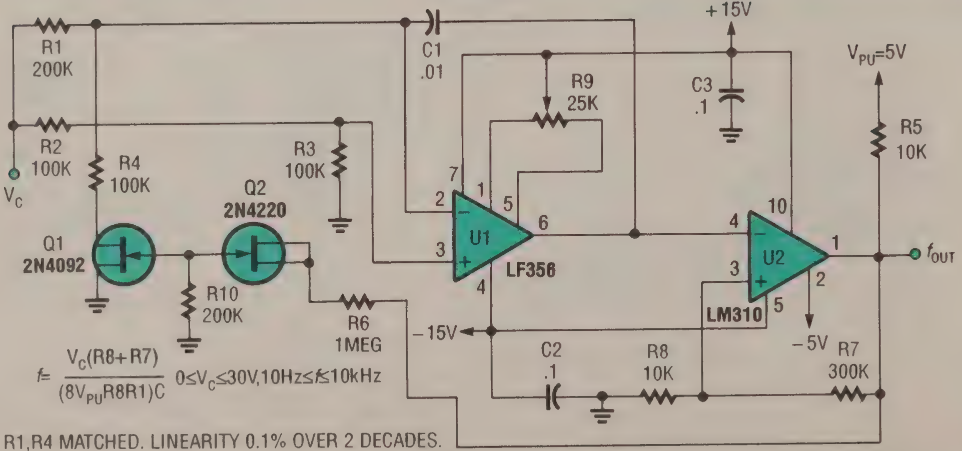
Popular Electronics **FactCard**

APPLICATIONS CIRCUITS

3 DECADE VCO



$$f = \frac{V_C(R8+R7)}{(8V_{PU}R8R1)C} \quad 0 \le V_C \le 30V, 10Hz \le f \le 10kHz$$

R1,R4 MATCHED. LINEARITY 0.1% OVER 2 DECADES.

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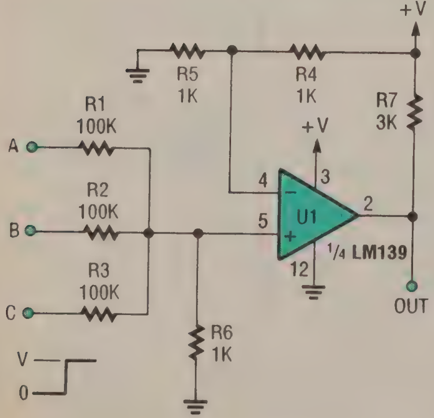
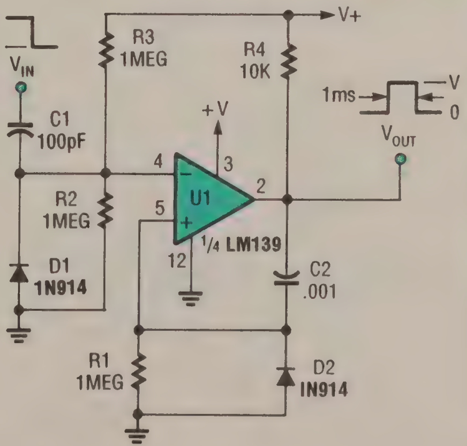
APPLICATIONS CIRCUITS

AND GATE



ONE-SHOT MULTIVIBRATOR



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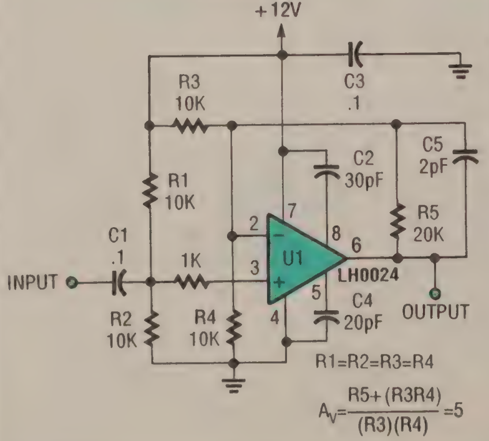
APPLICATIONS CIRCUITS

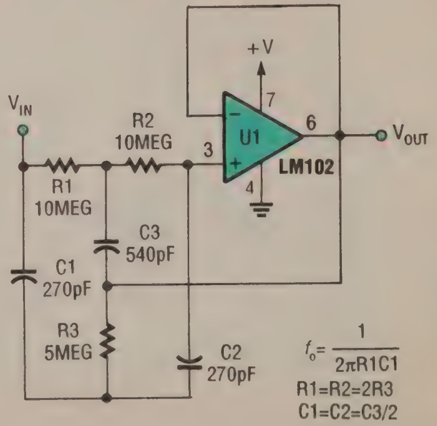
VIDEO AMPLIFIER



R1=R2=R3=R4

$$A_V = \frac{R5 + (R3R4)}{(R3)(R4)} = 5$$

HIGH Q NOTCH FILTER

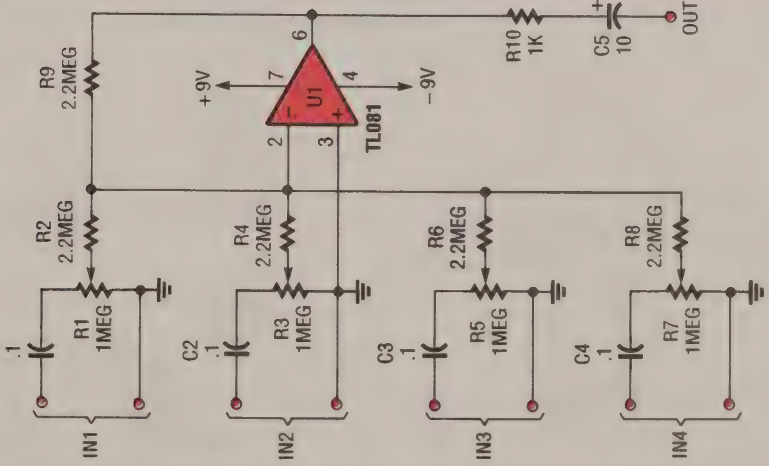


$$f_o = \frac{1}{2\pi R1C1}$$

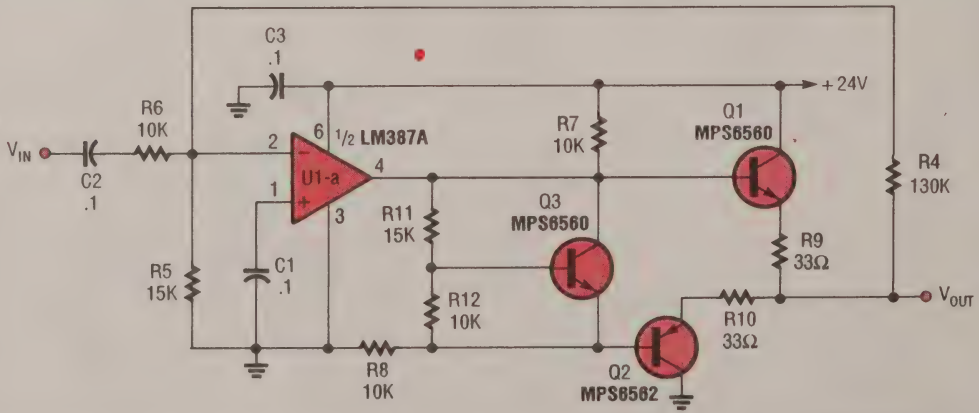
R1=R2=2R3

C1=C2=C3/2

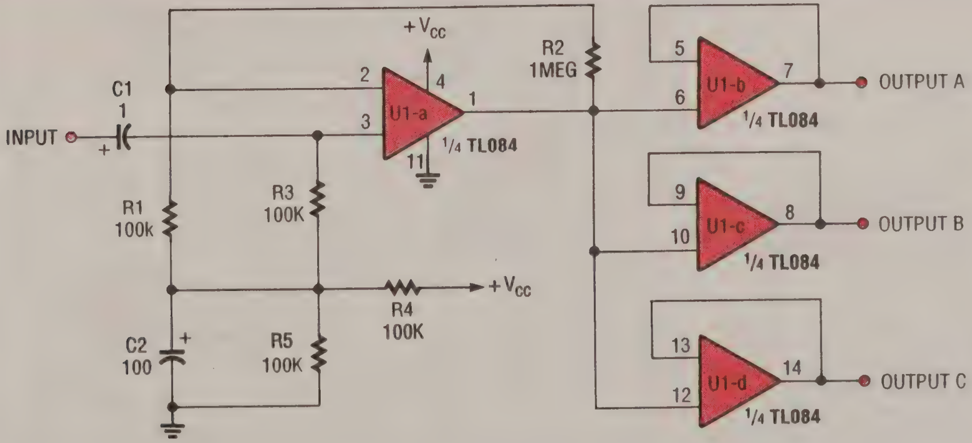
MICROPHONE MIXER



DISCRETE CURRENT BOOSTER



AUDIO DISTRIBUTION AMPLIFIER



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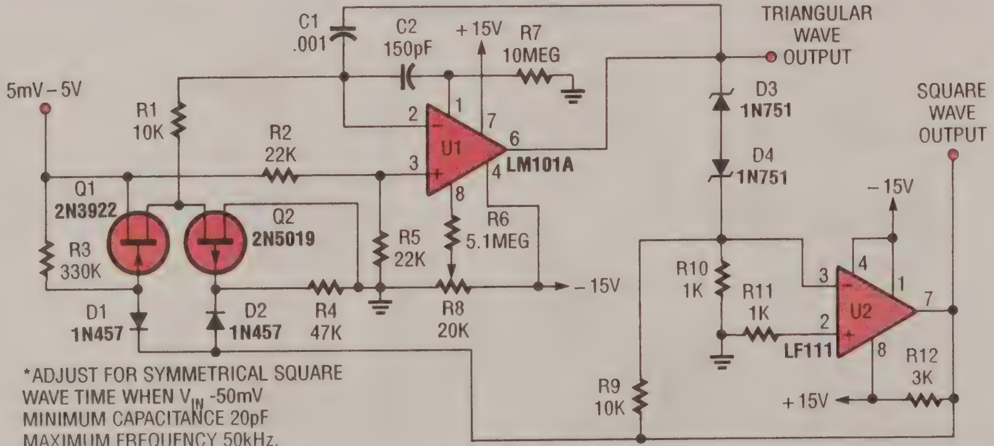
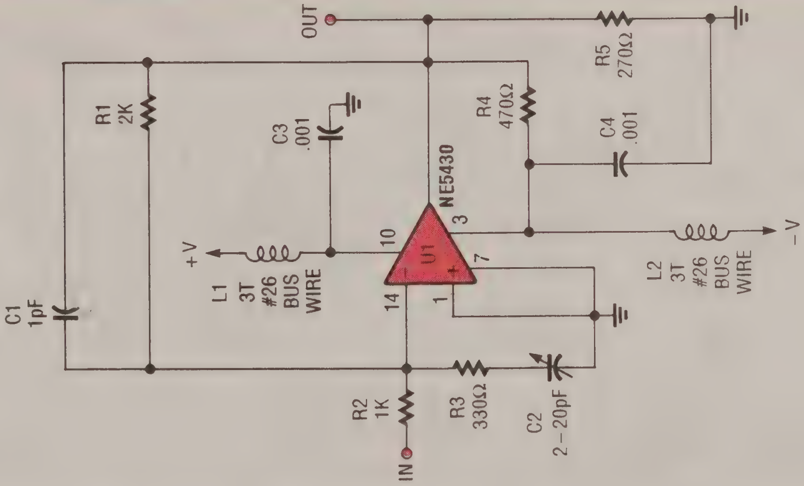
APPLICATIONS CIRCUITS

10Hz TO 10kHz VOLTAGE CONTROLLED OSCILLATOR



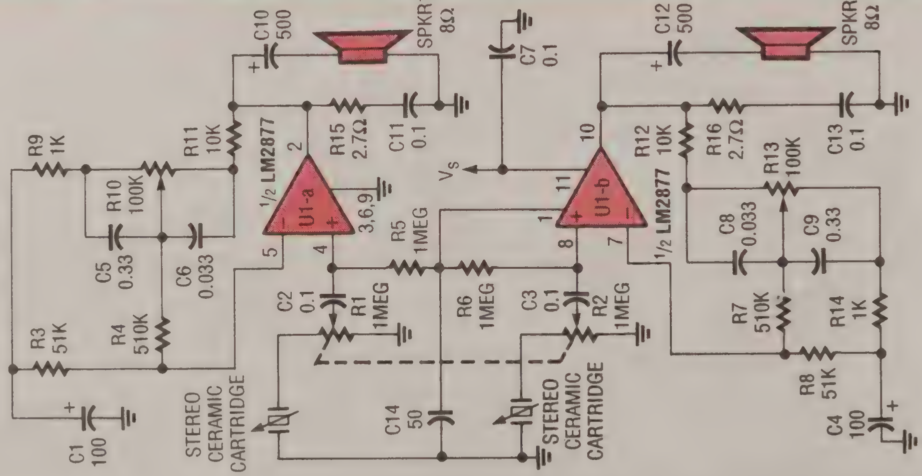
*ADJUST FOR SYMMETRICAL SQUARE WAVE TIME WHEN V_{IN} -50mV
MINIMUM CAPACITANCE 20pF
MAXIMUM FREQUENCY 50kHz.

UHF AMPLIFIER

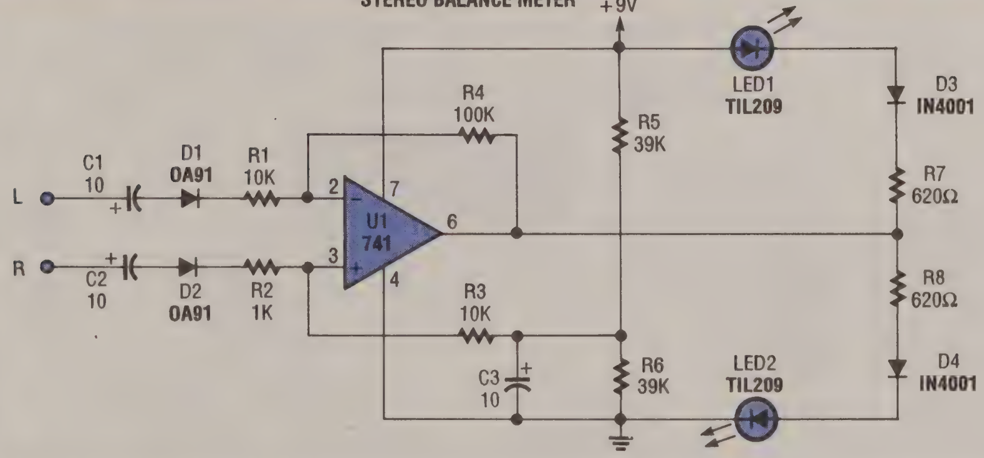


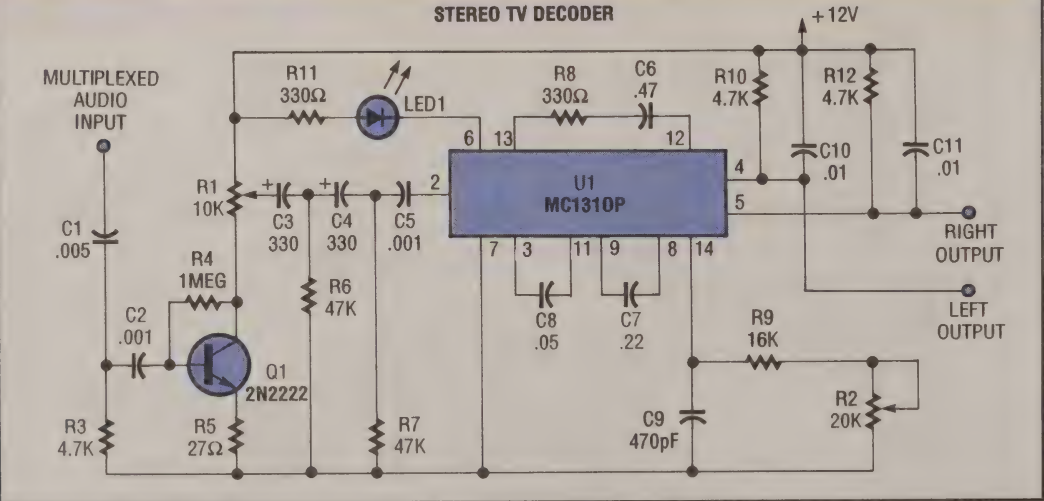
NOTE
RESISTORS-1/4 WATT CARBON.
L1 & L2 WOUND ON FERROXCUBE VK200 09/3B
WIDEBAND THREADED CORE.

STEREO PHONOGRAPH AMPLIFIER WITH BASS TONE CONTROL

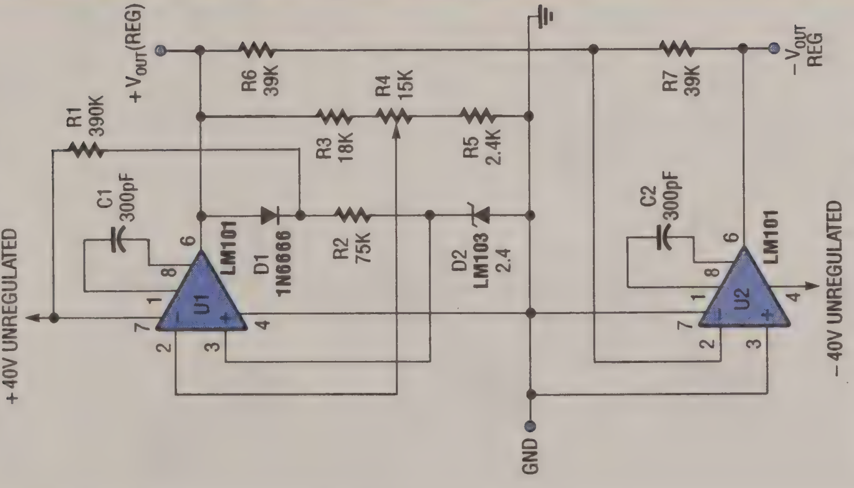


STEREO BALANCE METER




STEREO TV DECODER
+12V
MULTIPLEXED AUDIO INPUT
R11 330Ω
LED1
R8 330Ω
C6 .47
R10 4.7K
R12 4.7K
C10 .01
C11 .01
U1 MC1310P
6
13
12
4
5
2
7
3
11
9
8
14
R1 10K
C3 330
C4 330
C5 .001
C1 .005
R4 1MEG
C2 .001
Q1 2N2222
R6 47K
R7 47K
R3 4.7K
R5 27Ω
C8 .05
C7 .22
R9 16K
C9 470pF
R2 20K
RIGHT OUTPUT
LEFT OUTPUT

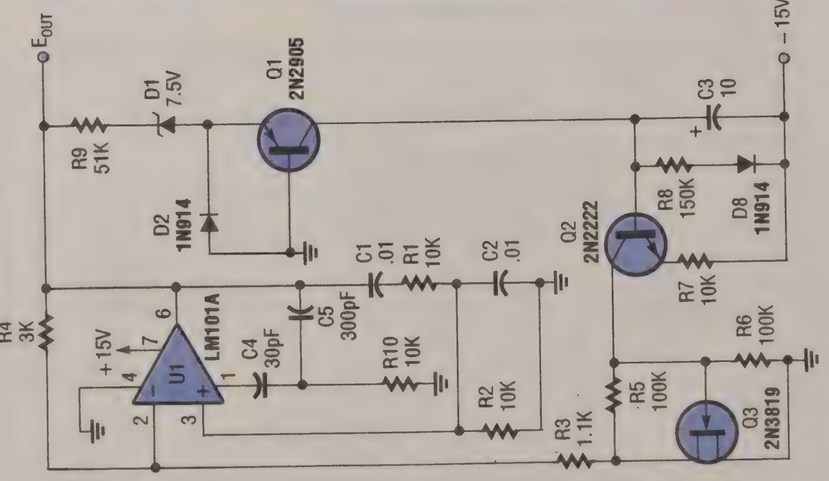
TRACKING POWER SUPPLY



OUTPUT VOLTAGE IS VARIABLE FROM ±5V TO ±35V.

NEGATIVE OUTPUT TRACKS POSITIVE OUTPUT TO WITHIN THE RATIO OF R6 TO R7.

WEIN-BRIDGE OSCILLATOR WITH FET AMPLITUDE STABILIZATION



$$f = \frac{1}{2\pi R1C1}$$

C1 = C2

R1 = R2

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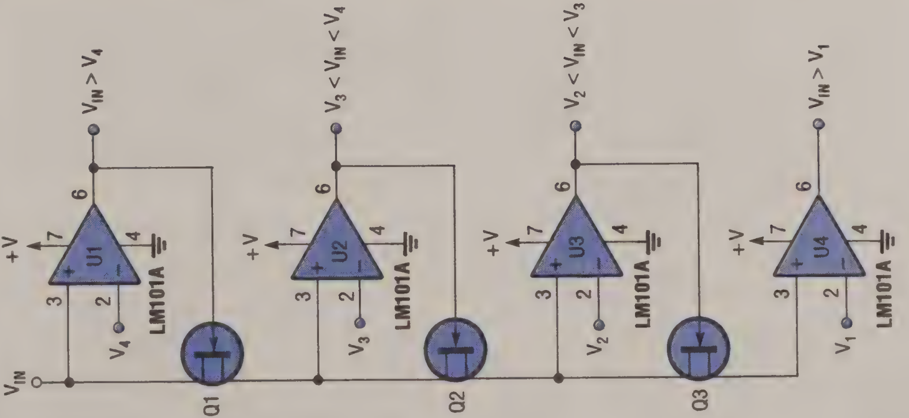
APPLICATIONS CIRCUITS

MULTIPLE APERTURE WINDOW DISCRIMINATOR



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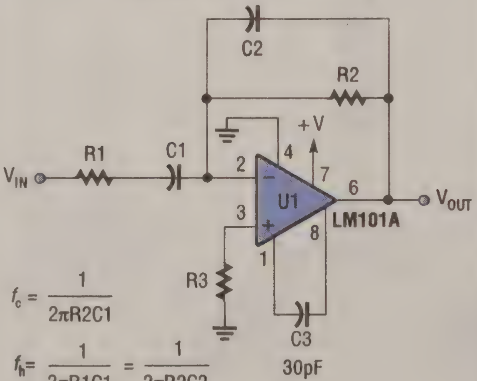
APPLICATIONS CIRCUITS

PRACTICAL DIFFERENTIATOR

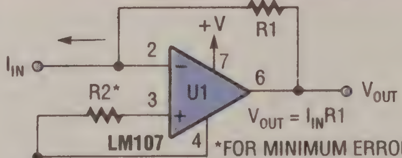


$$f_c = \frac{1}{2\pi R2C1}$$

$$f_h = \frac{1}{2\pi R1C1} = \frac{1}{2\pi R2C2}$$

$f_c < f_h < f_{\text{unity gain}}$

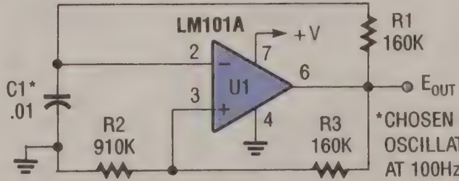
CURRENT TO VOLTAGE CONVERTER



$V_{OUT} = I_{IN}R1$

*FOR MINIMUM ERROR DUE TO BIAS CURRENT R2 = R1

FREE-RUNNING MULTIVIBRATOR



*CHOSEN FOR OSCILLATION AT 100Hz

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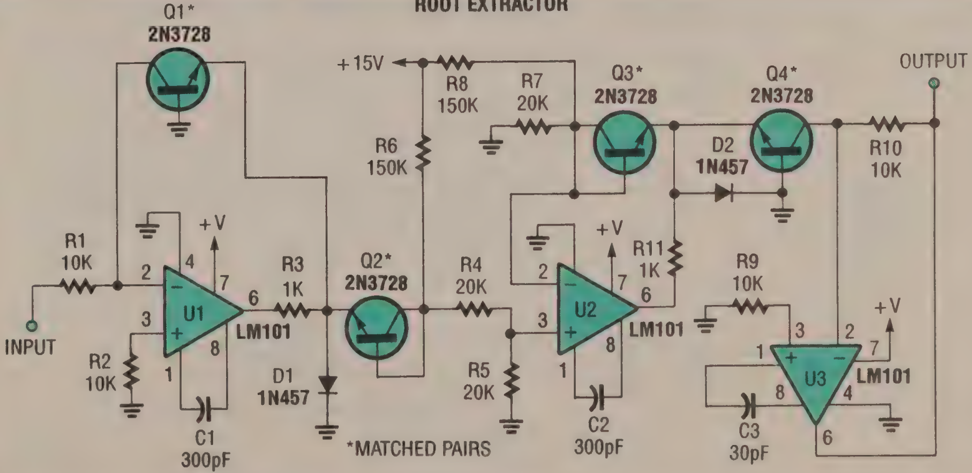
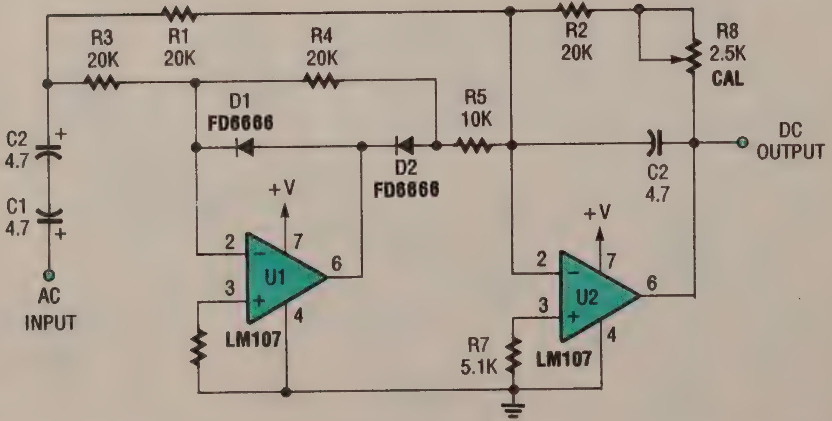
ROOT EXTRACTOR



FULL-WAVE RECTIFIER AND AVERAGING FILTER



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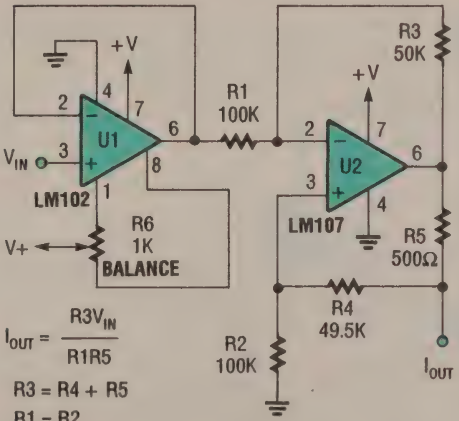
APPLICATIONS CIRCUITS

BILATERAL CURRENT SOURCE



$$I_{OUT} = \frac{R3V_{IN}}{R1R5}$$

$R3 = R4 + R5$

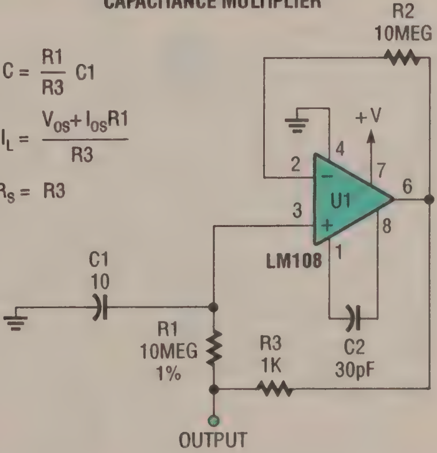
$R1 = R2$

CAPACITANCE MULTIPLIER

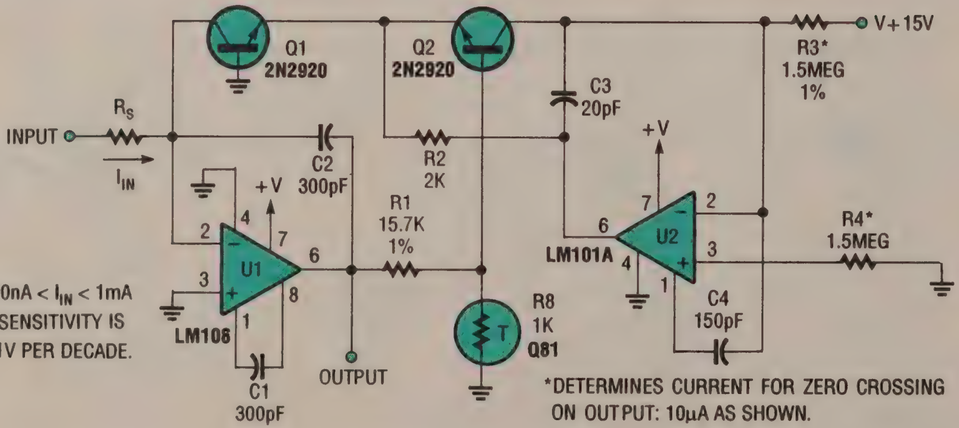
$$C = \frac{R1}{R3}\ C1$$

$$I_L = \frac{V_{OS} + I_{OS}R1}{R3}$$

$R_S = R3$



TEMPERATURE COMPENSATED ONE-QUADRANT LOGARITHMIC CONVERTER



$10nA < I_{IN} < 1mA$
SENSITIVITY IS
1V PER DECADE.

*DETERMINES CURRENT FOR ZERO CROSSING ON OUTPUT: 10µA AS SHOWN.

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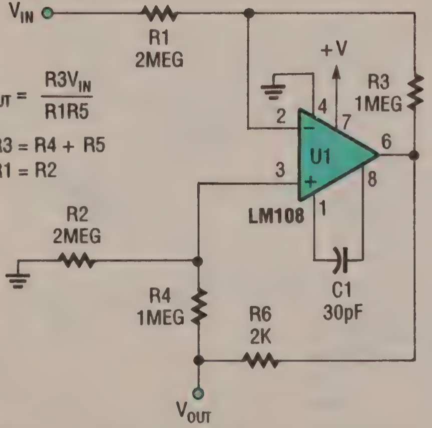
APPLICATIONS CIRCUITS

BILATERAL CURRENT SOURCE

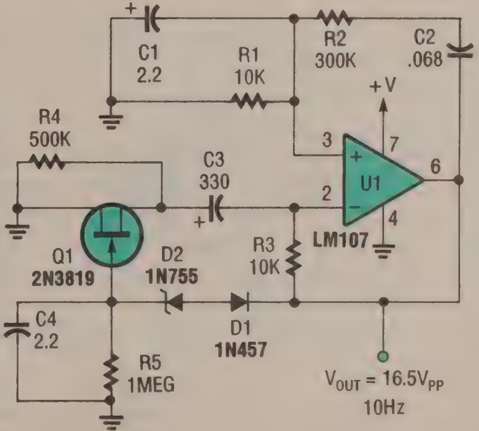


$$I_{OUT} = \frac{R3V_{IN}}{R1R5}$$

$R3 = R4 + R5$

$R1 = R2$

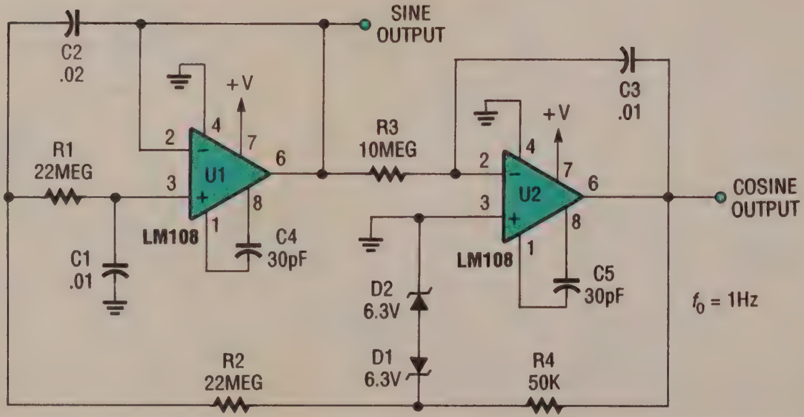
WIEN-BRIDGE SINEWAVE OSCILLATOR



$V_{OUT} = 16.5V_{PP}$

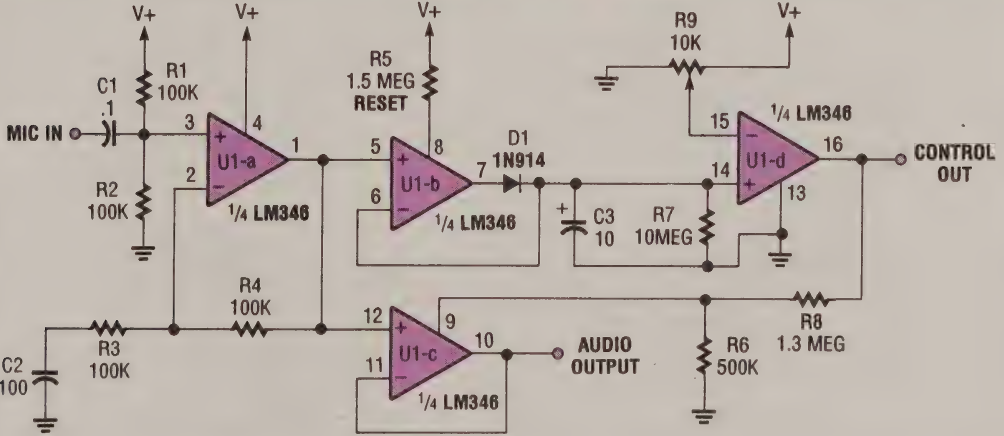
10Hz

SINEWAVE OSCILLATOR

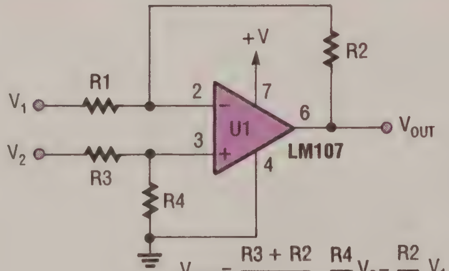


f_0 = 1Hz

VOICE ACTIVATED SWITCH AND AMPLIFIER



DIFFERENCE AMPLIFIER



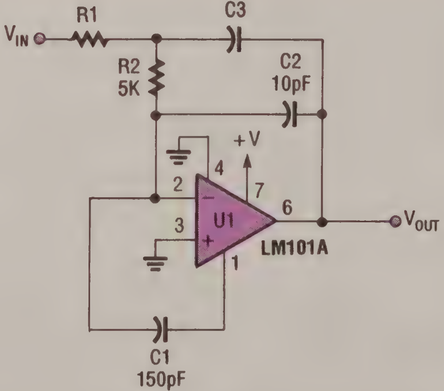
$$V_{OUT} = \frac{R3 + R2}{R1 + R4}\ \frac{R4}{R1} V_2 - \frac{R2}{R1}\ V_1$$

FOR R1 = R3 AND R2 = R4

$$V_{OUT} = \frac{R2}{R1}\ (V_2 - V_1)$$

R1||R2=R3||R4

FAST INTEGRATOR



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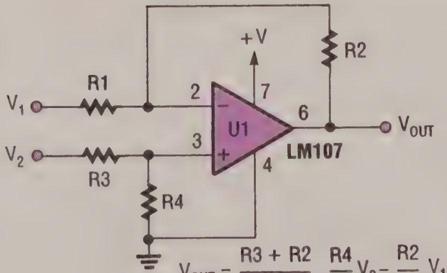
APPLICATIONS CIRCUITS

DIFFERENCE AMPLIFIER



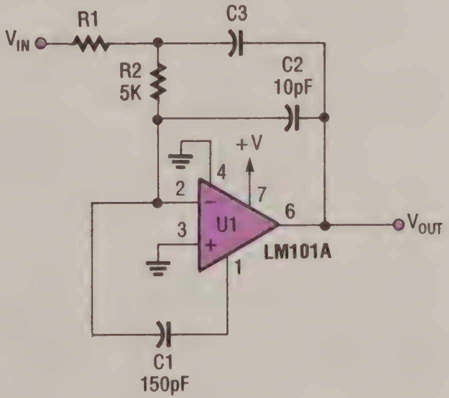
$$V_{OUT} = \frac{R3 + R2}{R1 + R4}\ \frac{R4}{R1} V_2 - \frac{R2}{R1}\ V_1$$

FOR R1 = R3 AND R2 = R4

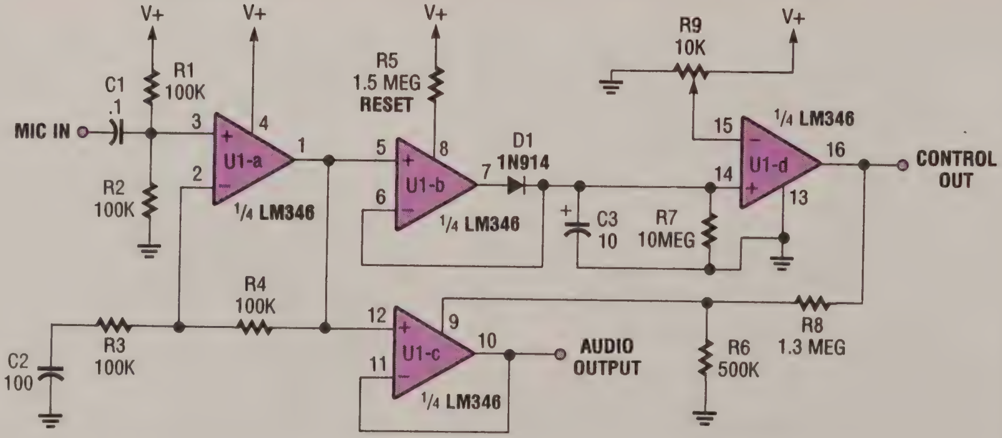
$$V_{OUT} = \frac{R2}{R1}\ (V_2 - V_1)$$

R1||R2=R3||R4

FAST INTEGRATOR

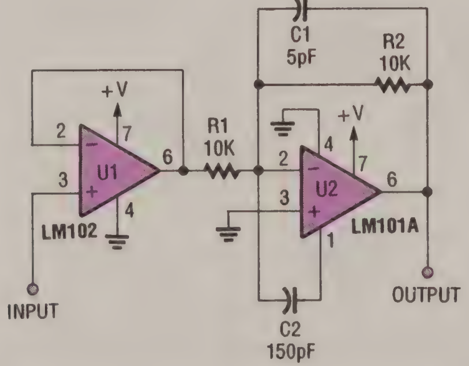


VOICE ACTIVATED SWITCH AND AMPLIFIER

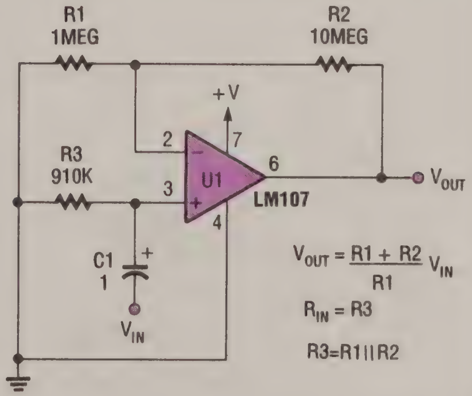


APPLICATIONS CIRCUITS

FAST INVERTING AMPLIFIER WITH HIGH INPUT IMPEDANCE



NON-INVERTING AC AMPLIFIER

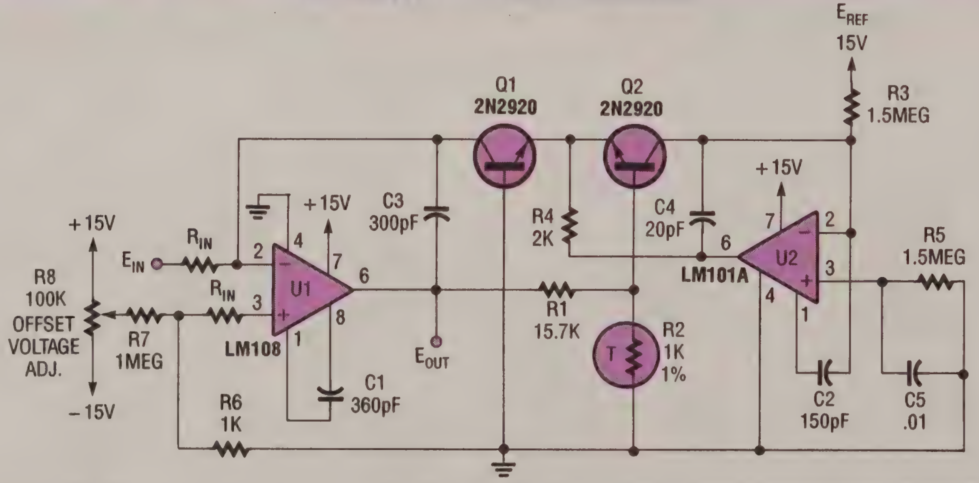


$$V_{OUT} = \frac{R1 + R2}{R1} V_{IN}$$

$R_{IN} = R3$

$R3 = R1 || R2$

LOG GENERATOR WITH 100dB DYNAMIC RANGE



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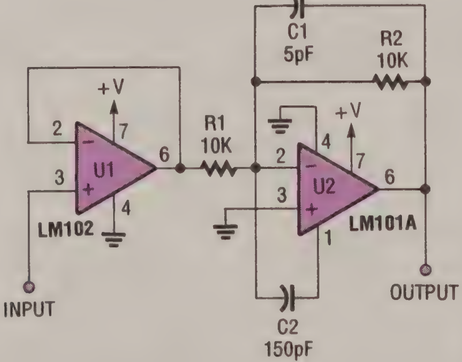
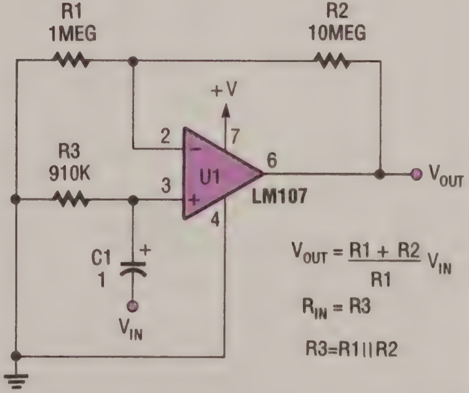
APPLICATIONS CIRCUITS

FAST INVERTING AMPLIFIER WITH HIGH INPUT IMPEDANCE



NON-INVERTING AC AMPLIFIER



$$V_{OUT} = \frac{R1 + R2}{R1} V_{IN}$$

$R_{IN} = R3$

$R3 = R1 || R2$

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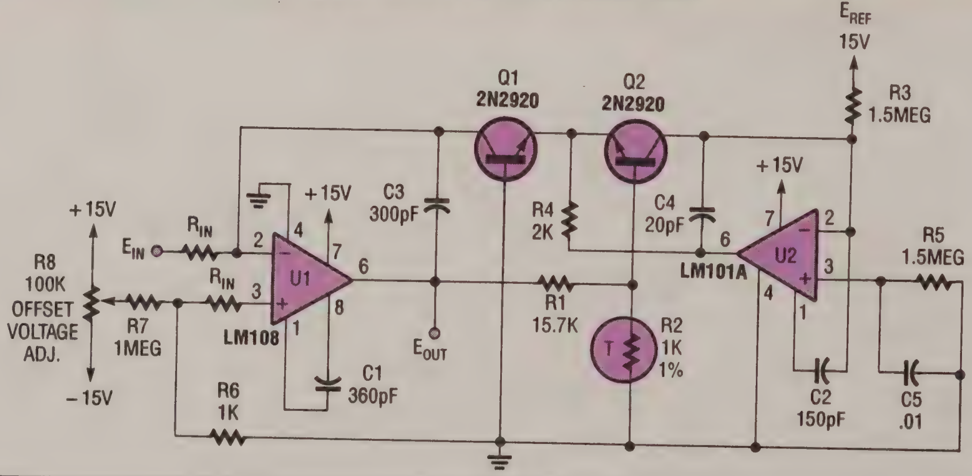
APPLICATIONS CIRCUITS

LOG GENERATOR WITH 100dB DYNAMIC RANGE



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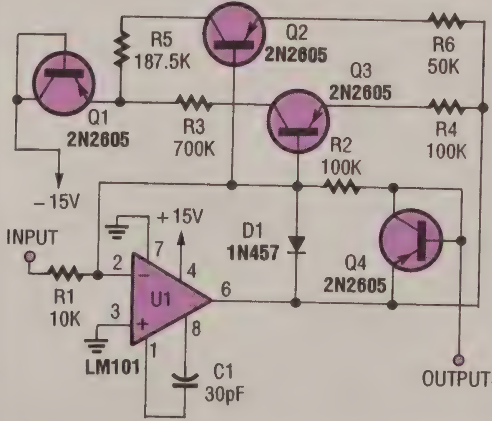
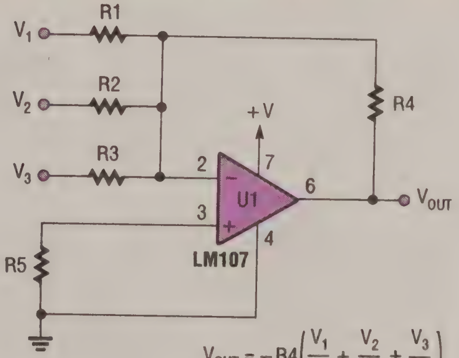
APPLICATIONS CIRCUITS

NONLINEAR OPERATIONAL AMPLIFIER WITH TEMPERATURE-COMPENSATED BREAKPOINTS



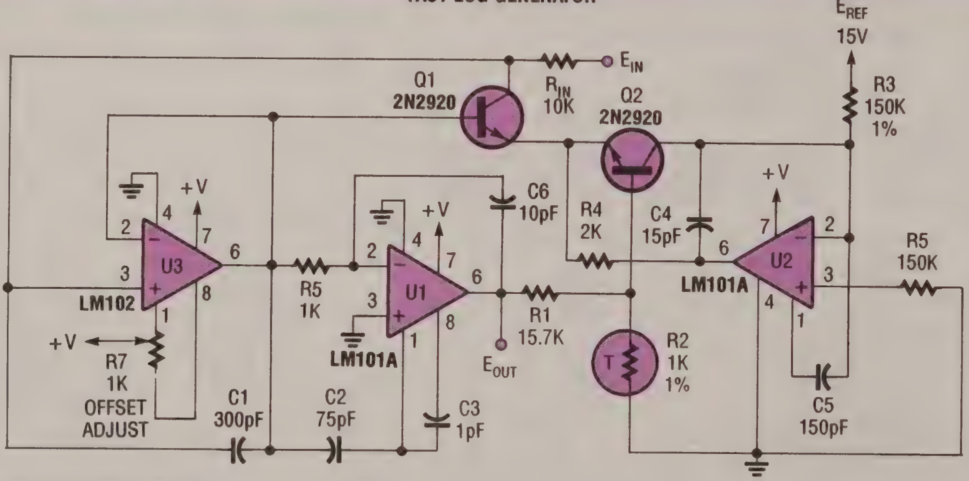
INVERTING SUMMING AMPLIFIER



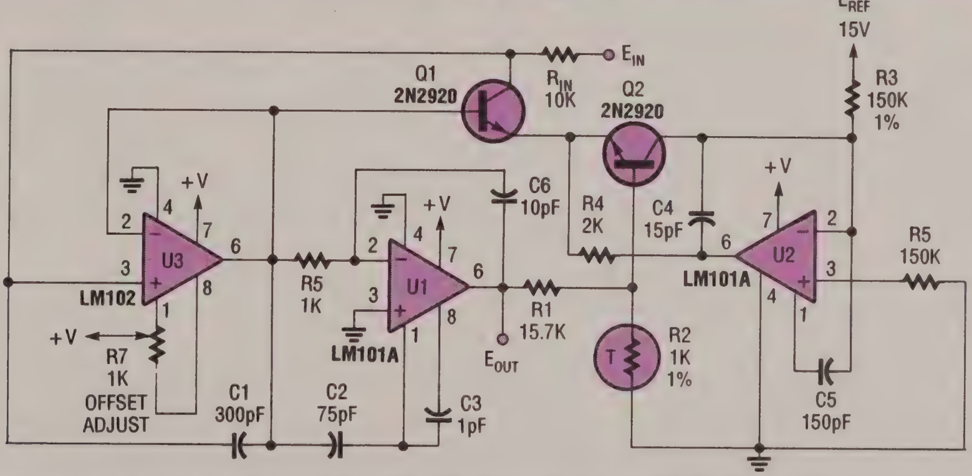
$$V_{OUT} = -R4\left(\frac{V_1}{R1} + \frac{V_2}{R2} + \frac{V_3}{R3}\right)$$

R5= R1||R2||R3||R4

FAST LOG GENERATOR



FAST LOG GENERATOR



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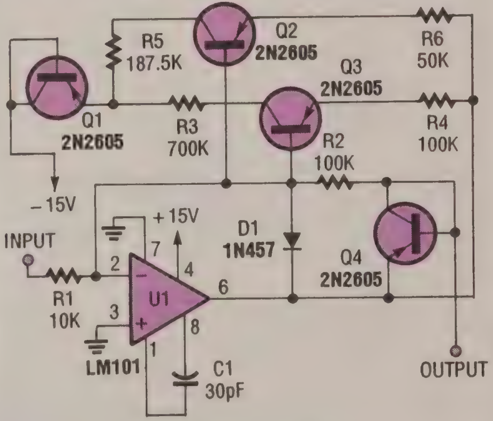
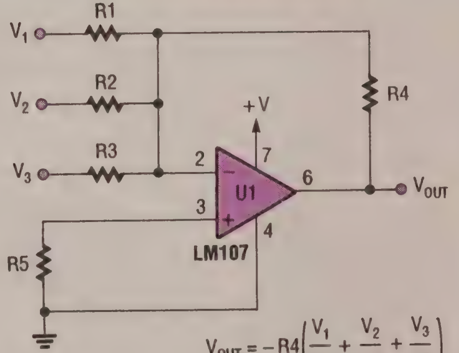
APPLICATIONS CIRCUITS

NONLINEAR OPERATIONAL AMPLIFIER WITH TEMPERATURE-COMPENSATED BREAKPOINTS



INVERTING SUMMING AMPLIFIER



$$V_{OUT} = -R4\left(\frac{V_1}{R1} + \frac{V_2}{R2} + \frac{V_3}{R3}\right)$$

$$R5 = R1 || R2 || R3 || R4$$

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Logic Probe (7611)

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IR Intruder Alarm
Intruder Detector Receiver (7611/4046/74HC00)
Intruder Detector Transmitter (7555/transistor)

FACTCARD 235
Applications Circuits:
Difference Amplifier (1458)
Differential Amplifier (741)
Gas/Smoke Detector

FACTCARD 236
Applications Circuits:
20-watt Audio Amplifier (transistor)
Audio Preamplifier (transistor)

FACTCARD 237
Applications Circuits:
Window Comparator (1458)
Peak Voltage Detector (1458)
Active Volume Control (LM380)
Pulse Generator (1458)

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Notch Filter (4136)
Notch Filter (4136)
Voltage-Controlled Oscillator (4136)

FACTCARD 239
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1-kHz Bandpass Filter
RIAA Preamplifier (4136)

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Active Lowpass Filter (LM110)
High-Q Notch Filter (LM110)
Universal State-Variable Filter (LF147)

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Fourth Order Highpass Filter (LF353)
Tunable Notch Filter (LM307)
High Q Bandpass Filter (LM357)

FACTCARD 228
Applications Circuits:
Simulated Inductor (LM110)
Bandpass Filter (LM110)
Fourth Order Lowpass Filter (LF357)
Active Highpass Filter (LM110)

FACTCARD 229
Transistor Applications:
Crystal-Controlled Hartley Oscillator
Monostable Multivibrator
Low-Level Audio Amplifier
Audio Oscillator

FACTCARD 230
Transistor Applications:
Colpitts Oscillator
Astable Multivibrator
Schmitt Trigger
Phase-Shift Oscillator

FACTCARD 231
Passive Filter Circuits:
L-Filters: Lowpass/Highpass (RC AND LC)
PI Filters: Lowpass/Highpass (RC AND LC)
T Filters: Lowpass/Highpass (RC AND LC)

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Wein Bridge Oscillator (transistor)
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SAA3028 IR Receiver

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FACTCARD 219
HI384 CMOS Analog Switch

FACTCARD 220
SAF1032 IR Receiver

FACTCARD 221
Applications Circuits:
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Signal Tracer (transistor)
Audio Frequency Meter (transistor)
Squarewave Generator (transistor)

FACTCARD 222
SAA1039 IR Transmitter

FACTCARD 223
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Active Lowpass RC Filter (LM124)
Squarewave Oscillator (LM124)
Push-Pull Darlington Amplifier (transistor)

FACTCARD 224
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Bi-Quad RC Bandpass Filter (LM124)
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Touch Switch (4049)

FACTCARD 207
LM2889 TV video modulator

FACTCARD 208
LM1201 video amplifier system

FACTCARD 209
Applications Circuits:
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Audio Preamplifier (transistor)
Audio Mixer Circuit (transistor)
Guitar Preamplifier (transistor)

FACTCARD 210
LM2005 20-Watt Automotive Power Amplifier

FACTCARD 211
HI201HS High-Speed SPST CMOS Analog Switch

FACTCARD 212
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IR Transmitter (NE555V)
IR FM Transmitter (NE555V)
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FACTCARD 213
HI200 Dual SPST CMOS Analog Switch

FACTCARD 214
HI201 Quad SPST CMOS Analog Switch

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MM54HC112/MM74HC112 dual J-K Flip-Flop with Preset and Clear

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LM1872 Radio Control Receiver/Decoder

FACTCARD 197
LM1771 RC Encoder Transmitter

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Applications Circuits

FACTCARD 199
LM3820 AM Radio System

FACTCARD 200
LM1800 Phase-Locked Loop

FACTCARD 201
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LM1889 TV Video Modulator

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MM54HC74/MM74HC74 Dual D Flip-Flop with Preset and Clear

FACTCARD 182
MM54HC73/MM74HC73 Dual J-K Flip-Flop with Clear

FACTCARD 183
MM54HC51/MM74HC51 Dual AND-OR-invert Gate

FACTCARD 184
MM54C30/MM74C30 8-input NAND Gate

FACTCARD 185
Applications Circuits

FACTCARD 186
MM5271 4096-bit (4096 × 1) TTL-Compatible Dynamic RAM

FACTCARD 187
MM54HC86/MM74HC86 Quad 2-input Exclusive OR Gate

FACTCARD 188
MM54HC85/MM74HC85 4-bit Magnitude Comparator

FACTCARD 189
MM54HC123A/MM74HC123A Dual Retriggerable Monostable Multivibrator

FACTCARD 190
MM54HC107/MM74HC107 Dual J-K Flip-Flop with Clear

FACTCARD 191
MM54HC109/MM74HC109 Dual J-K Flip-Flop with Preset and Clear

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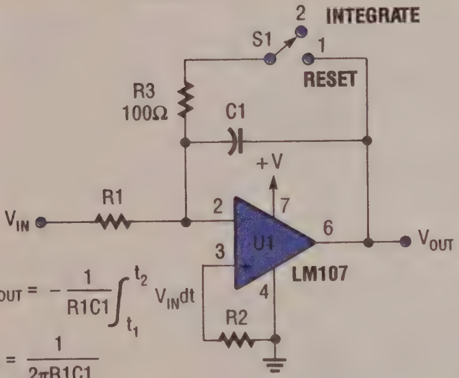
APPLICATIONS CIRCUITS

INTEGRATOR



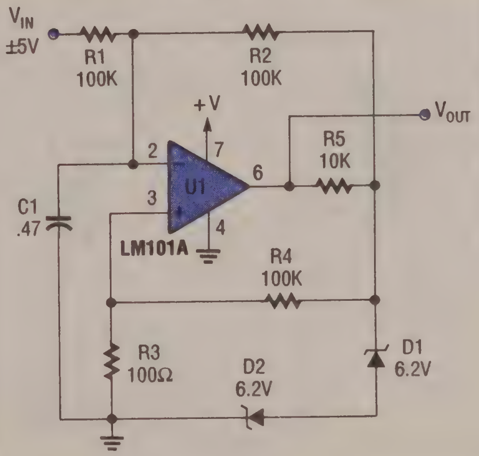
$$V_{OUT} = -\frac{1}{R1C1}\int_{t_1}^{t_2} V_{IN}dt$$

$$f_c = \frac{1}{2\pi R1C1}$$

R1 = R2

FOR MINIMUM OFFSET ERROR DUE TO INPUT BIAS CURRENT

PULSE WIDTH MODULATOR



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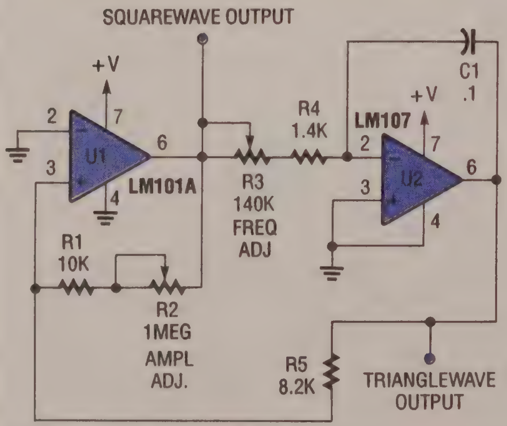
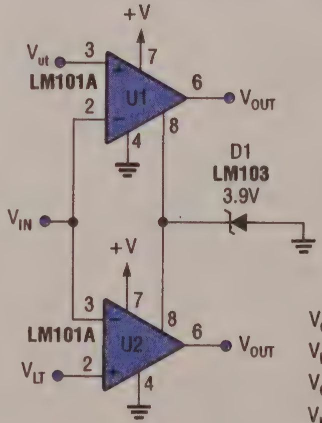
APPLICATIONS CIRCUITS

FUNCTION GENERATOR



DOUBLE-ENDED LIMIT DETECTOR



V_{OUT} = 4.6V FOR

$V_{LT} \leq V_{IN} \leq V_{UT}$

V_{OUT} = 0V FOR

$V_{IN} < V_{LT}$ OR $V_{IN} > V_{UT}$

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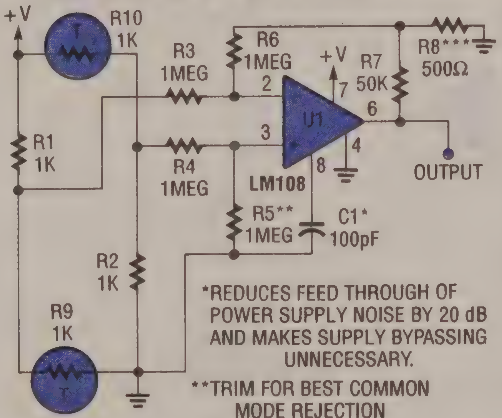
APPLICATIONS CIRCUITS

BRIDGE AMPLIFIER WITH LOW NOISE COMPENSATION

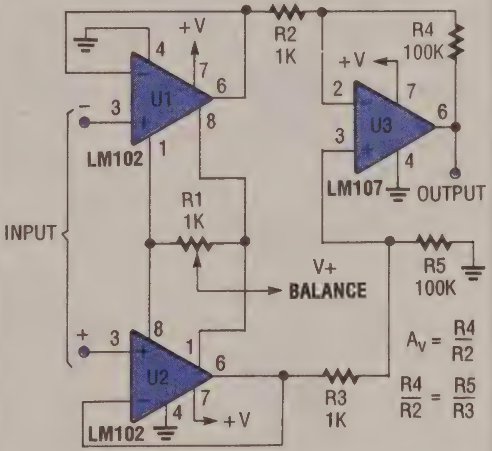


*REDUCES FEED THROUGH OF POWER SUPPLY NOISE BY 20 dB AND MAKES SUPPLY BYPASSING UNNECESSARY.

**TRIM FOR BEST COMMON MODE REJECTION

***GAIN ADJUST

DIFFERENTIAL-INPUT INSTRUMENTATION AMPLIFIER



$$A_V = \frac{R4}{R2}$$

$$\frac{R4}{R2} = \frac{R5}{R3}$$

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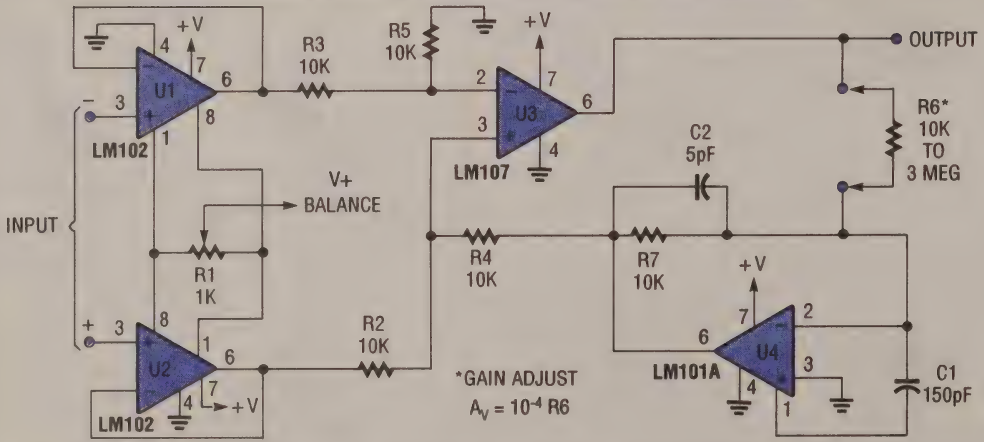
APPLICATIONS CIRCUITS

VARIABLE GAIN, DIFFERENTIAL-INPUT INSTRUMENTATION AMPLIFIER



*GAIN ADJUST

$A_V = 10^{-4}\,R6$

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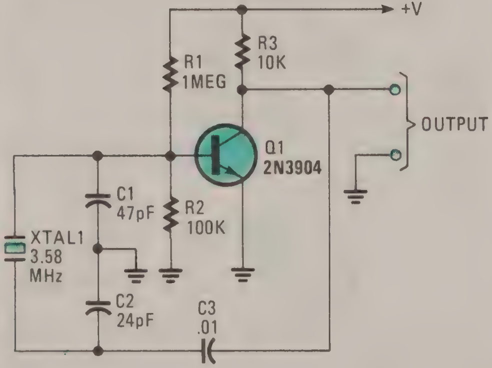
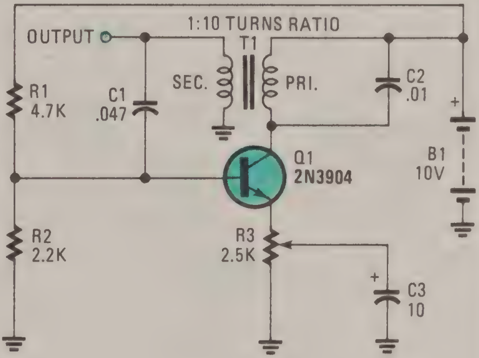
APPLICATION CIRCUITS

PIERCE OSCILLATOR

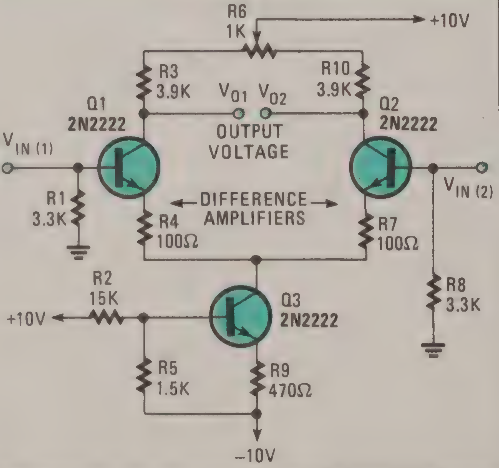


ARMSTRONG OSCILLATOR

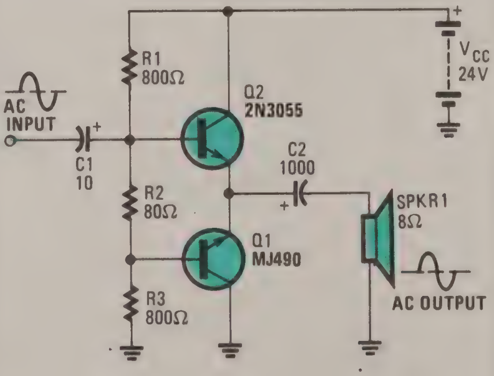


APPLICATION CIRCUITS

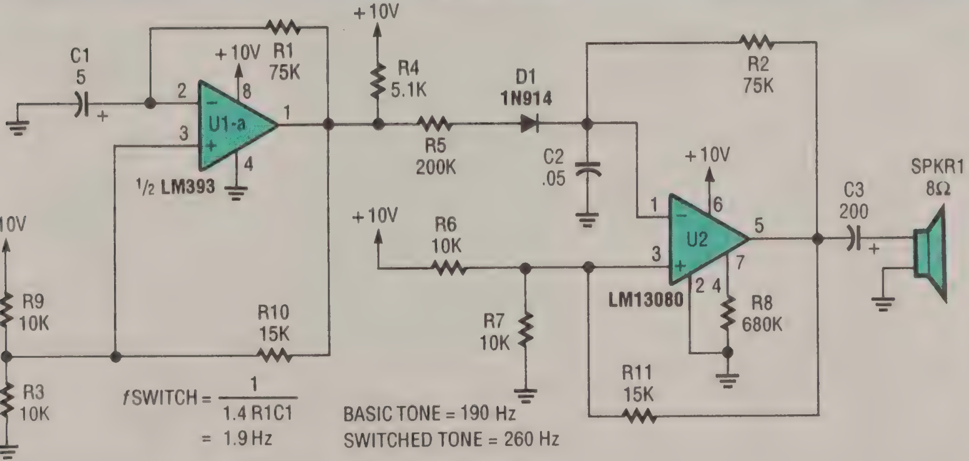
DIFFERENCE AMPLIFIER



COMPLEMENTRY SEMMETRY AMPLIFIER



TWO-TONE SIREN

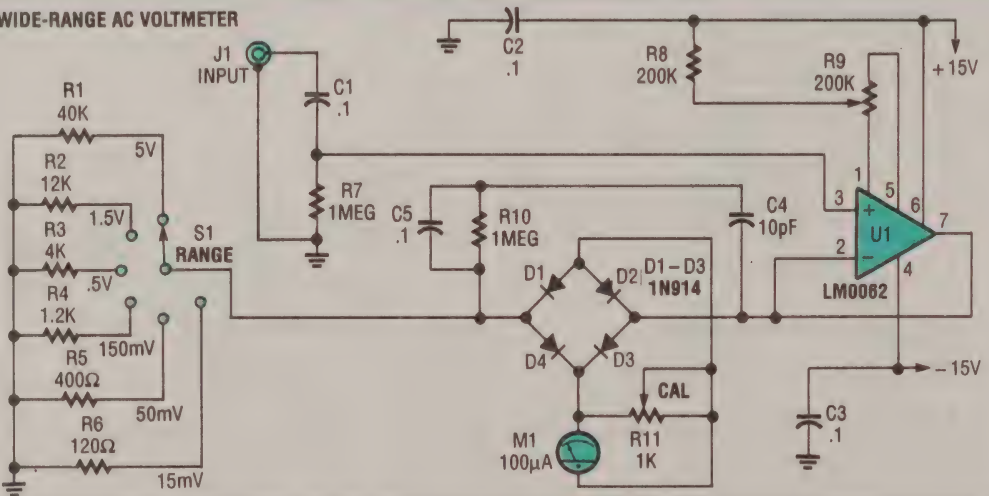


$$f\text{SWITCH} = \frac{1}{1.4\,R1C1} = 1.9\ \text{Hz}$$

BASIC TONE = 190 Hz

SWITCHED TONE = 260 Hz

WIDE-RANGE AC VOLTMETER



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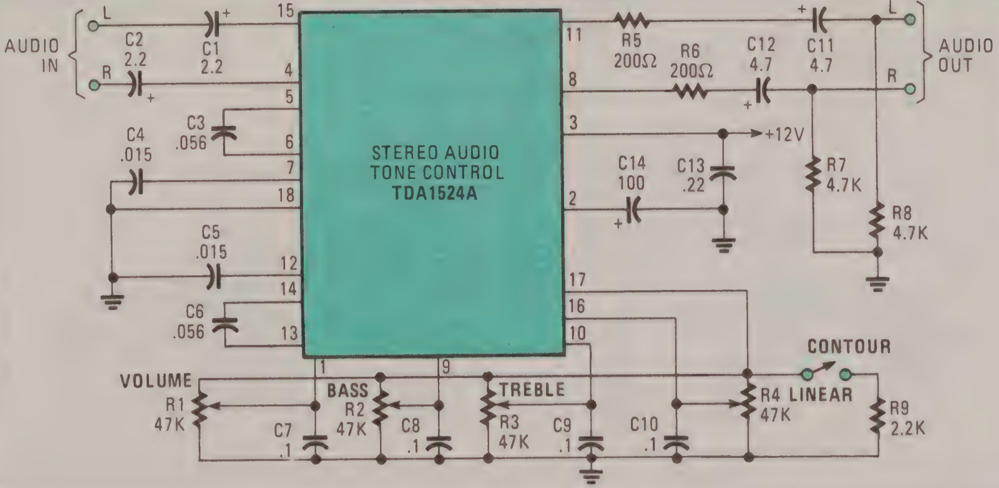
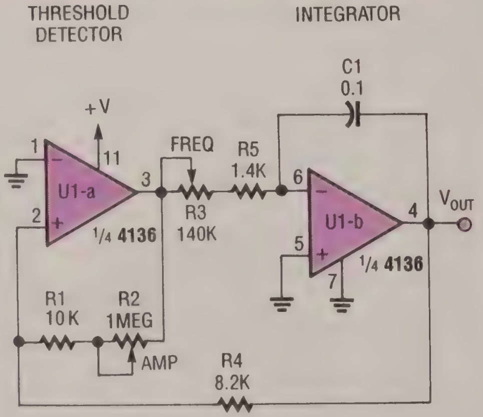
APPLICATION CIRCUITS

VOLUME/TONE CONTROL

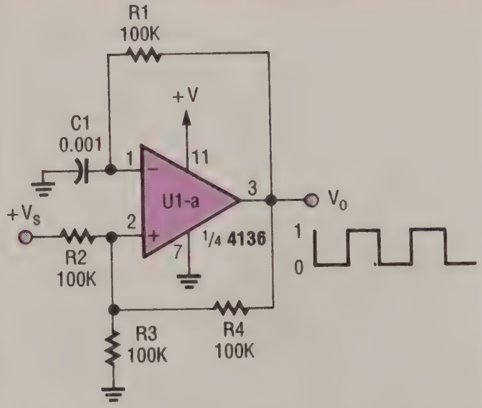


243 Popular Electronics FactCard Application Circuits

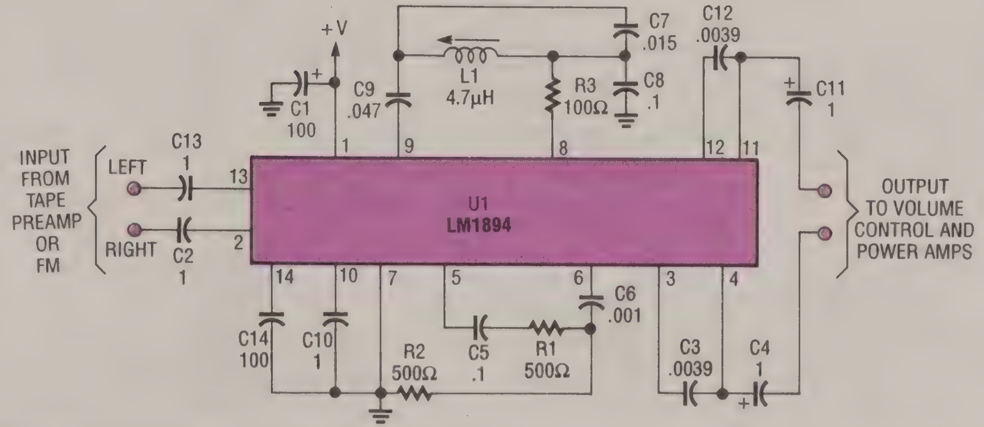
TRIANGLE-WAVE OSCILLATOR



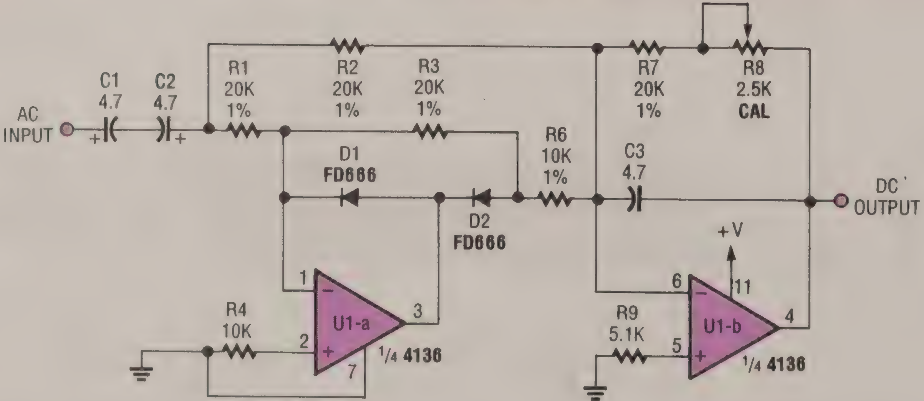
SQUAREWAVE OSCILLATOR



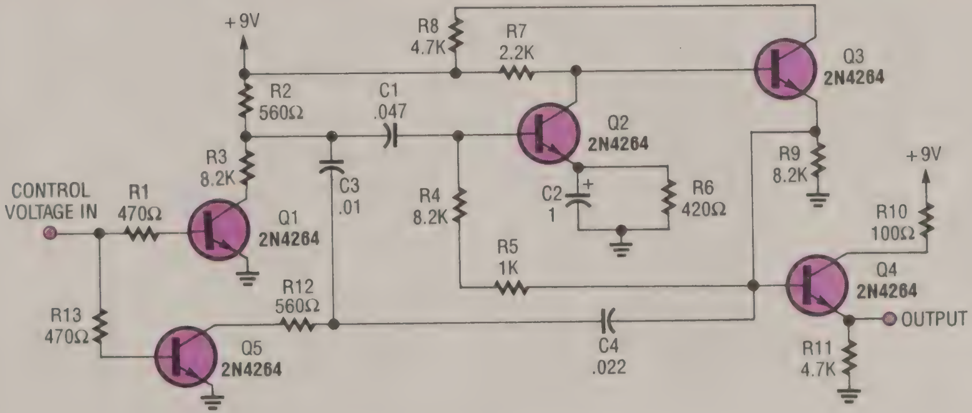
DNR SYSTEM


+V
C1
100
C9
.047
L1
4.7μH
R3
100Ω
C7
.015
C8
.1
C12
.0039
C11
1
INPUT FROM TAPE PREAMP OR FM
LEFT
RIGHT
C13
1
C2
1
U1
LM1894
1
9
8
12
11
13
2
14
10
7
5
6
3
4
C14
100
C10
1
R2
500Ω
C5
.1
R1
500Ω
C6
.001
C3
.0039
C4
1
OUTPUT TO VOLUME CONTROL AND POWER AMPS

FULL-WAVE RECTIFIER/AVERAGING FILTER



VOLTAGE-CONTROLLED SINEWAVE OSCILLATOR



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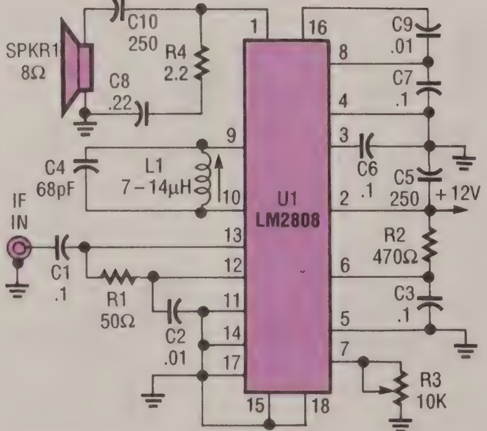
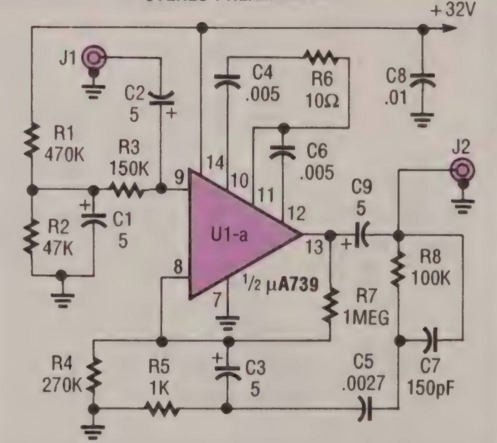
Application Circuits

TV SOUND SYSTEM

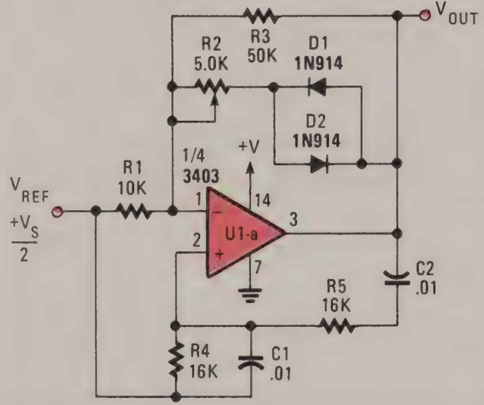


STEREO PREAMPLIFIER

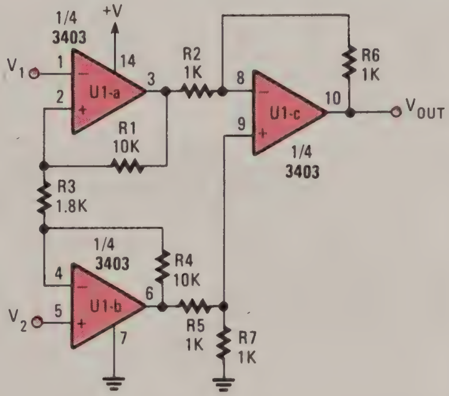


APPLICATION CIRCUITS

WEIN BRIDGE OSCILLATOR



HIGH IMPEDANCE DIFFERENTIAL AMPLIFIER



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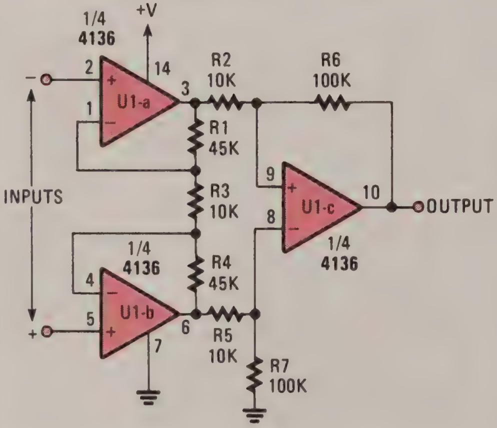
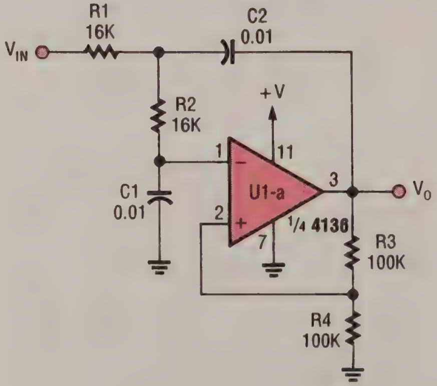
APPLICATION CIRCUITS

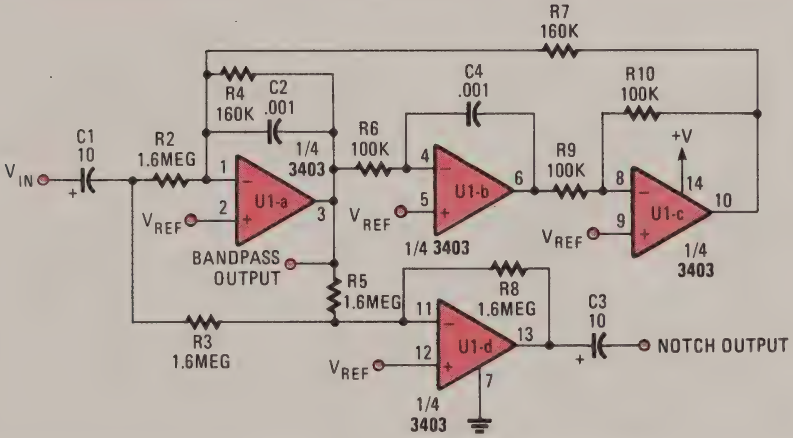
DIFFERENTIAL INPUT INSTRUMENTATION AMPLIFIER



DC-COUPLED 1kHz FILTER

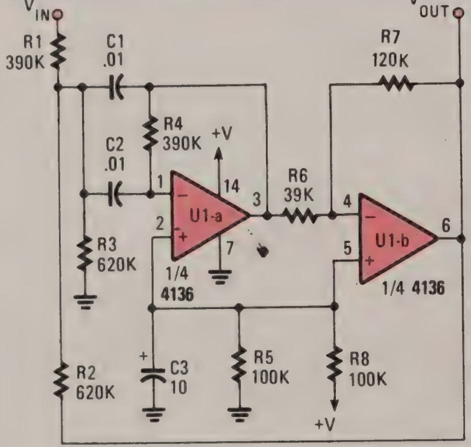


BI-QUAD FILTER

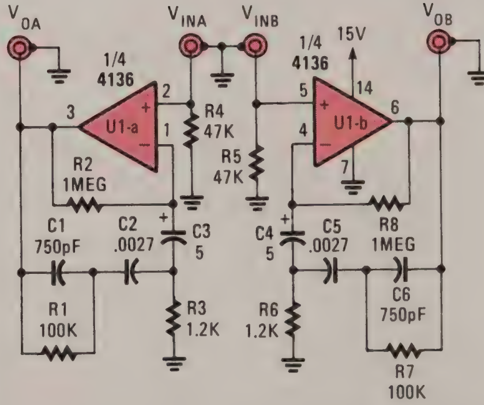


APPLICATION CIRCUITS

1KHz BANDPASS FILTER

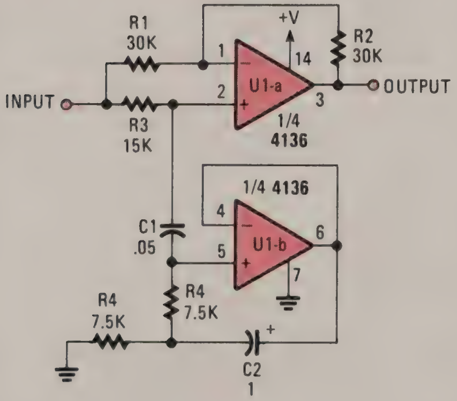


RIAA PREAMPLIFIER

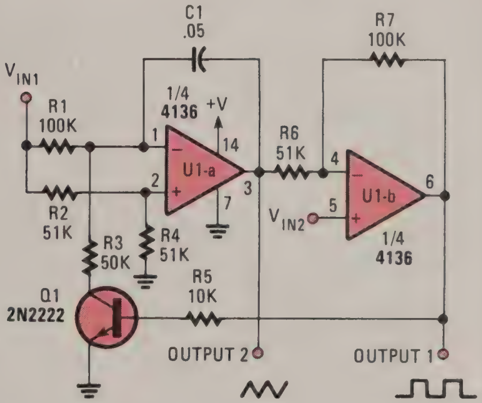


APPLICATION CIRCUITS

NOTCH FILTER



VOLTAGE CONTROLLED OSCILLATOR



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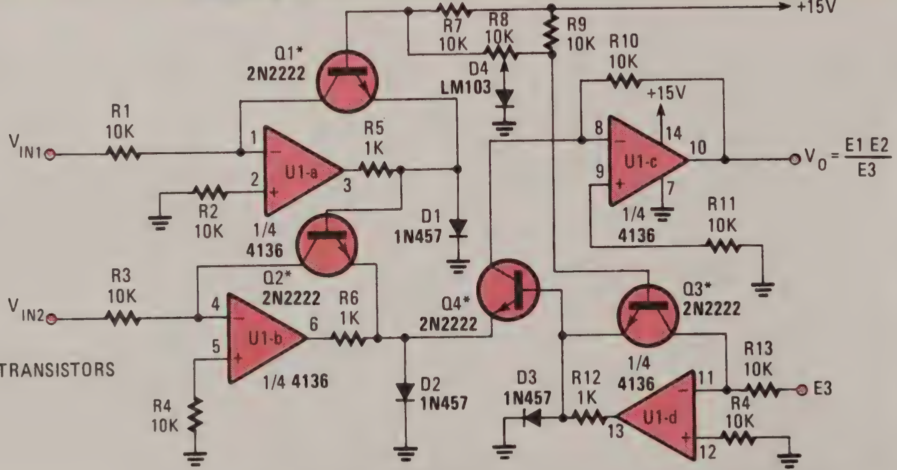
APPLICATION CIRCUITS

ANALOG MULTIPLIER/DIVIDER



*MATCHED TRANSISTORS

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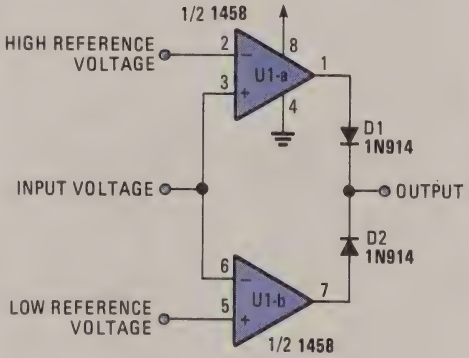
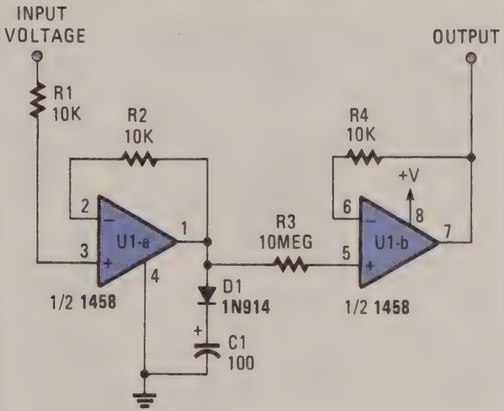
APPLICATION CIRCUITS

WINDOW COMPARATOR



PEAK VOLTAGE DETECTOR



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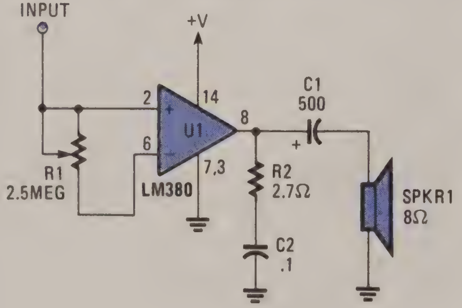
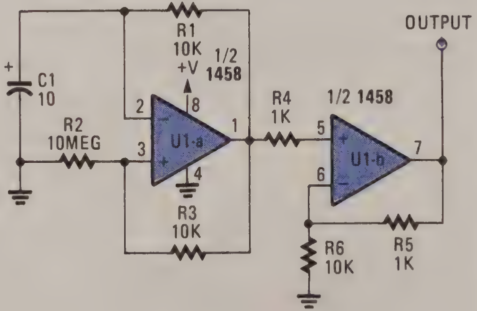
APPLICATION CIRCUITS

"ACTIVE" VOLUME CONTROL



PULSE GENERATOR



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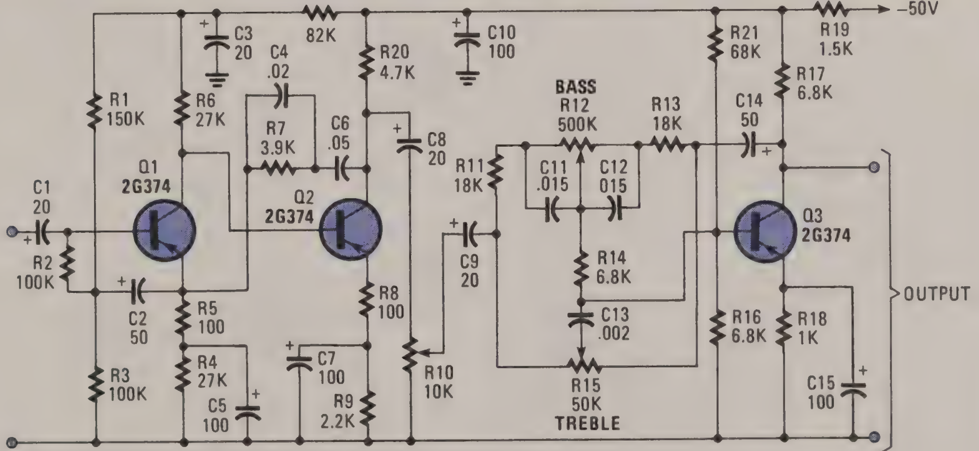
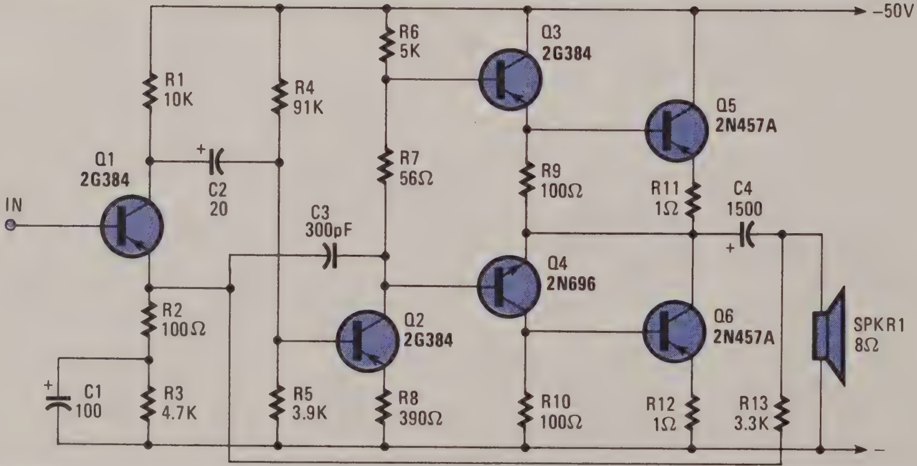
APPLICATION CIRCUITS

AUDIO PREAMPLIFIER



20-WATT AUDIO AMPLIFIER



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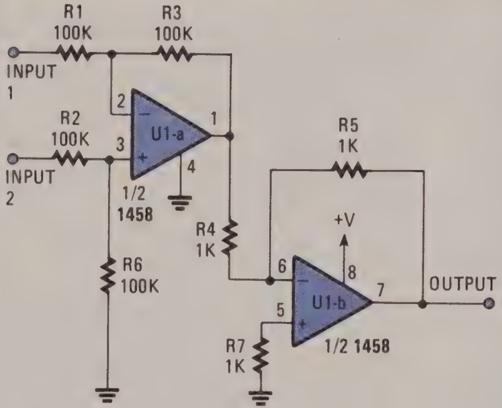
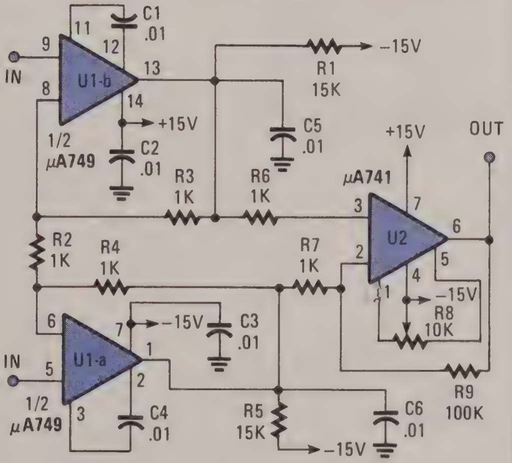
APPLICATION CIRCUITS

DIFFERENCE AMPLIFIER



DIFFERENTIAL AMPLIFIER



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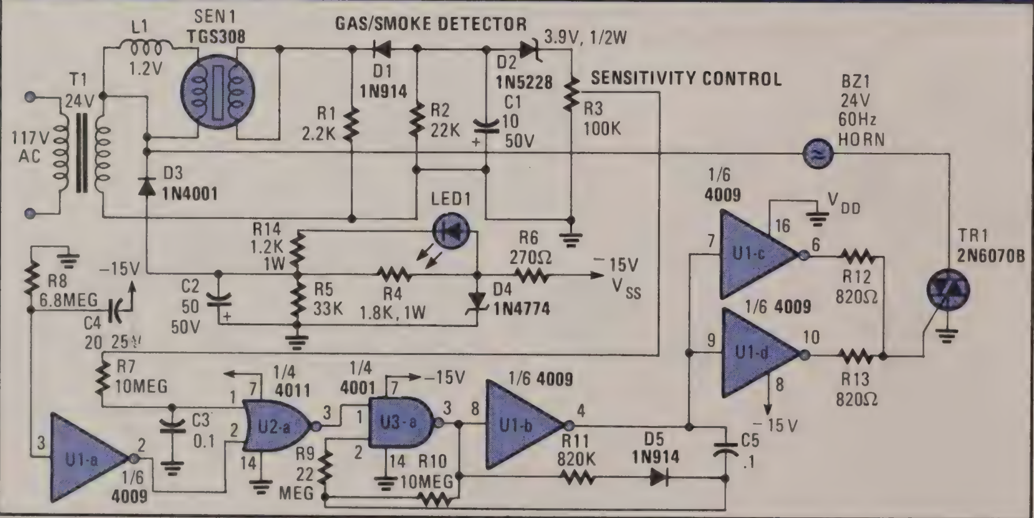
APPLICATION CIRCUITS



216 Popular Electronics **FactCard**

HI302 · HI306 · Dual SPST CMOS Analog Switch

ELECTRICAL SPECIFICATIONS

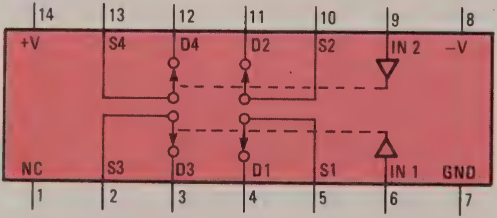
PARAMETER	TYP	UNITS
ANALOG SWITCH CHARACTERISTICS		
Analog Signal Range	±	V
R_{ON}, On Resistance	35	Ω
	40	Ω
$I_{S(OFF)}$, Off Input Leakage Current	0.04	nA
	1	nA
$I_{D(OFF)}$, Off Output Leakage Current	0.04	nA
	1	nA
$I_{D(ON)}$, On Leakage Current	0.03	nA
	0.5	nA
DIGITAL INPUT CHARACTERISTICS		
V_{INL}, Input Low Level*	—	V
V_{INH}, Input High Level*	—	V
V_{INL}, Input Low Level **	—	V
V_{INH}, Input High Level **	—	V
I_{INL}, Input Leakage Current (Low)	—	µA
I_{INH}, Input Leakage Current (High)	—	µA

PARAMETER	TYP	UNITS
SWITCHING CHARACTERISTICS		
t_{OPEN}, Break-Before Make Delay***	60	ns
t_{ON}, Switch On Time*	210	ns
t_{OFF}, Switch Off Time*	160	ns
t_{ON}, Switch Off Time**	160	ns
t_{OFF}, Switch Off Time**	100	ns
"Off Isolation"	60	dB
Charge Injection	3	mV
$C_{S(OFF)}$, Input Switch Capacitance	16	pF
$C_{D(OFF)}$, Output Switch Capacitance	14	pF
$C_{D(ON)}$, Output Switch Capacitance	35	pF
C_{IN}, (High) Digital Input Capacitance	5	pF
C_{IN}, (Low) Digital Input Capacitance	5	pF

216 Popular Electronics FactCard

HI302 • Dual SPST CMOS
HI306 • Analog Switch

HI-302 & HI-306



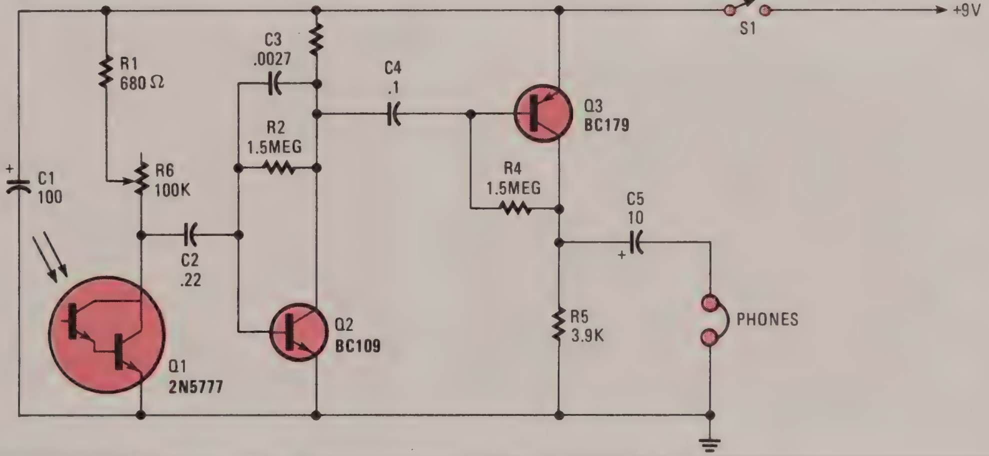
DESCRIPTION

The HI-302 and HI-306 series of switches are monolithic devices fabricated using CMOS technology and the Harris dielectric isolation process. These switches feature low and nearly constant ON resistance over the full analog signal range, and low power dissipation, (a few milliwatts for the HI-302, a few hundred microwatts for the HI-306).

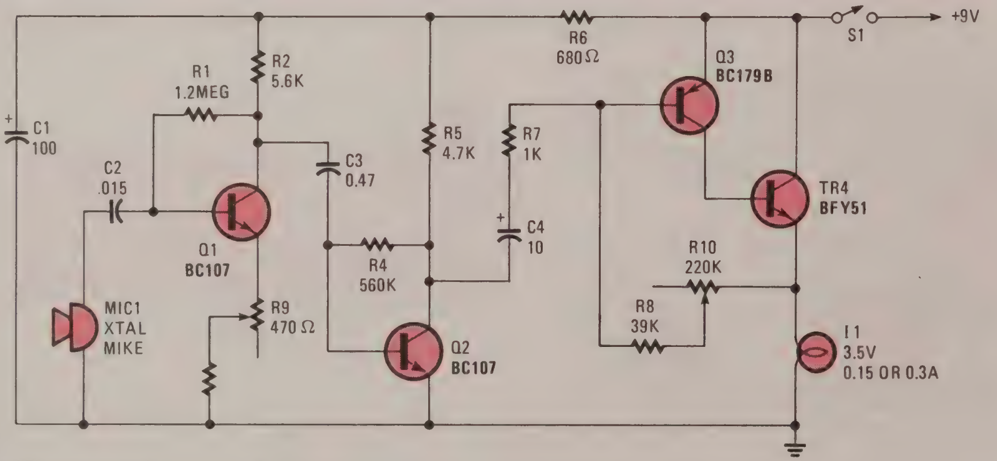
These switches are TTL compatible and have a logic "0" condition with an input less than 0.8V and a logic "1" condition with an input greater than 4.0V. The HI-304-307 switches are CMOS compatible and have a low state with an input less than 3.5V and a high state with an input greater than 11V. (See pinouts for switch conditions with a logic "1" input.)

Each of the switch types are available in either the −55°C to +125°C or 0°C to +75°C operating ranges.

MODULATED LIGHT RECEIVER



MODULATED LIGHT TRANSMITTER



214 Popular Electronics FactCard

HI201 : Quad SPST CMOS Analog Switch

ELECTRICAL SPECIFICATIONS

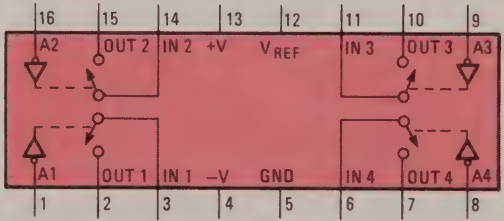
PARAMETER	TYP	UNITS
ANALOG SWITCH CHARACTERISTICS		
V_S, Analog Signal Range	±15	V
R_{ON}, On Resistance	55	Ω
	80	Ω
$I_{S(OFF)}$, Off Input Leakage Current	2	nA
	500*	nA
$I_{D(OFF)}$, Off Output Leakage Current	2	nA
	35	nA
$I_{D(ON)}$, On Leakage Current	2	nA
	500*	nA
DIGITAL INPUT CHARACTERISTICS		
V_{AL}, Input Low Threshold	0.8*	V
V_{AH}, Input High Threshold	2.4**	V
I_A, Input Leakage Current (High or Low)	1.0*	μA

PARAMETER	TYP	UNITS
SWITCHING CHARACTERISTICS		
t_{OPEN}, Break-Before Make Delay	30	ns
t_{ON}, Switch On Time	185	ns
	1000	ns
t_{OFF}, Switch Off Time	220	ns
	1000	ns
"Off Isolation"	80	dB
$C_{S(OFF)}$, Input Switch Capacitance	5.5	pF
$C_{D(OFF)}$, Output Switch Capacitance	5.5	pF
$C_{D(ON)}$, Output Switch Capacitance	11	pF
C_A, Digital Input Capacitance	5	pF
$C_{DS\ (OFF)}$, Drain-To-Source Capacitance	0.5	pF

214 Popular Electronics FactCard

HI201 : Quad SPST CMOS Analog Switch

HI1-201-X



DESCRIPTION

HI-201 is a monolithic device comprised of four independently selectable SPST switches which feature fast switching speeds (185ns) combined with low power dissipation (15mW at +25°C). Each switch provides low "ON" resistance operation for input signal voltages up to the supply rails and for signal currents up to 80mA. Employing Dielectric Isolation and CMOS processing, HI-201 operates without any applications problems induced by latch-up or SCR mode phenomena.

All devices provide break-before-make switching and are TTL and CMOS compatible for maximum application versatility. HI-201 is an ideal component for use in high frequency analog switching. Typical applications include signal path switching, sample and hold circuit, digital filters, and op amp gain switching networks.

HI-201 is available in a 16 lead Dual-In-Line package. HI-201-2 is specified from −55°C to +125°C while HI-201-5 operates from 0°C to +75°C. HI-201 is functionally and pin compatible with other available "200 series" switches.

204 Popular Electronics FactCard LM1889 : TV Video Modulator

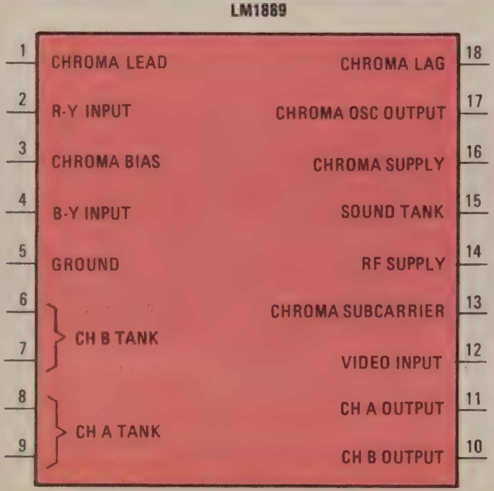
DC ELECTRICAL CHARACTERISTICS

Parameter	**Typ**	**Units**
Supply Curent	35	mA
Sound Oscillator, Current Change	0.6	mA
Chroma Oscillator Balance	11.0	V
Chroma Modulator Balance	7.4	V
R-Y Modulator Output Level	0.9	V
B-Y Modulator Output Level	0.9	V
Chroma Modulator Conversion Ratio	0.70	V/V
Ch. A Oscillator "OFF" Voltage	1.0	V

Parameter	**Typ**	**Units**
Ch. A Oscillator Current Level	4.0	mA
Ch. B Oscillator "OFF" Voltage	1.0	V
Ch. B. Oscillator Current Level	4.0	mA
Ch. A. Modulator Conversion Ratio	0.55	V/V
Ch. B. Modulator Conversion Ratio	0.55	V/V

204 Popular Electronics FactCard

LM1889 : TV Video Modulator



GENERAL DESCRIPTION

The LM1889 is designed to interface audio, color difference, and luminance signals to the antenna terminals of a TV receiver. It consists of a sound subcarrier oscillator, chroma subcarrier oscillator, quadrature chroma modulators, and RF oscillators and modulators for two low-VHF channels.

The LM1889 allows video information from VTR's, games, test equipment, or similar sources to be displayed on black and white or color TV receivers. When used with the MM57100 and MM53104, a complete TV game is formed.

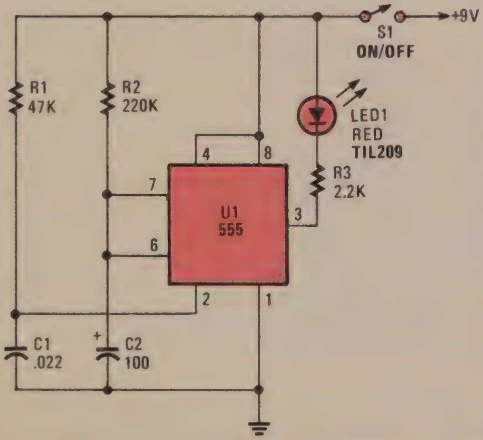
FEATURES

- DC channel switching
- 12V to 18V supply operation
- Excellent oscuillator stability
- Low intermodulation products
- 5 Vp-p chroma reference signal
- May be used to encode composite video

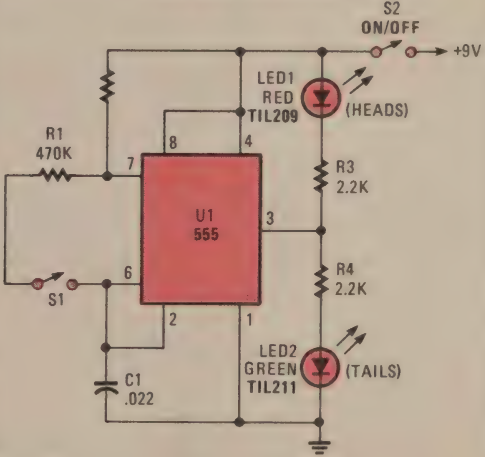
203 Popular Electronics FactCard

Applications Circuits

GAMES TIMER



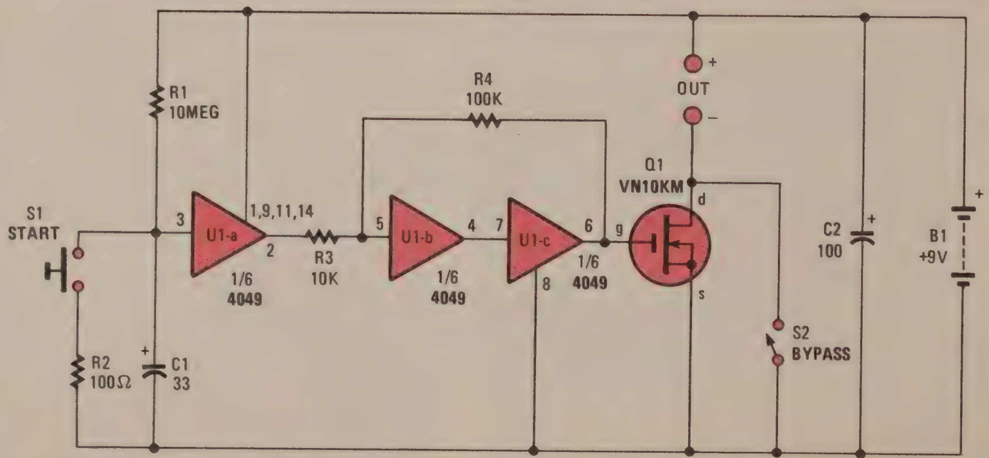
HEADS OR TAILS CIRCUIT



203 Popular Electronics **FactCard**

Applications Circuits

SLEEP TIMER



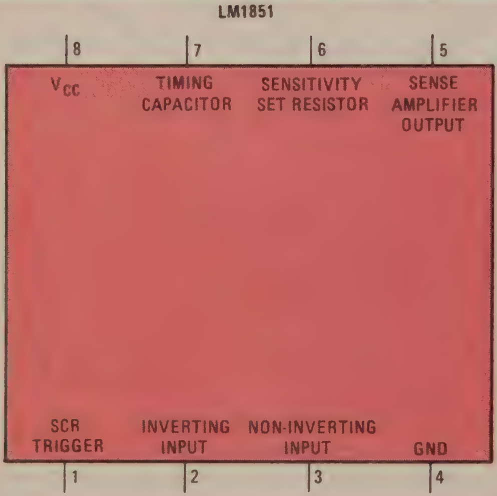
202 Popular Electronics **FactCard**

LM1851: Ground Fault Interrupter

DC ELECTRICAL CHARACTERISTICS

Parameter	Typ	Units
Power Supply Shunt Regulator Voltage	26	V
Latch Trigger Voltage	17.5	V
Sensitivity Set Voltage	7	V
Output Drive Current	1	mA
Output Saturation Voltage	100	mV
Output Saturation Resistance	100	Ω
Output External Current Sinking Capability	5	mA
Noise Integration Sink Current Ratio	2.8	µA/µA

202 Popular Electronics FactCard LM1851: Ground Fault Interrupter



GENERAL DESCRIPTION

The LM1851 is designed to provide ground fault protection for AC power outlets in consumer and industrial environments. Ground fault currents greater than a presettable threshold value will trigger an external SCR-driven circuit breaker to interrupt the AC line and remove the fault condition. In addition to detection of conventional hot wire to ground faults, the neutral fault condition is also detected.

Full advantage of the U.S. UL943 timing specification is taken to insure maximum immunity to false triggering due to line noises. Special features include circuitry that rapidly resets the timing capacitor in the event that noise pulses introduce unwanted charging currents and a memory circuit that allows firing of even a sluggish breaker on either half-cycle of the line voltage when external full-wave rectification is used.

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192 Popular Electronics FactCard

MM74HC112 · Dual J-K Flip-Flop MM54HC112 · with Preset and Clear

DC ELECTRICAL CHARACTERISTICS

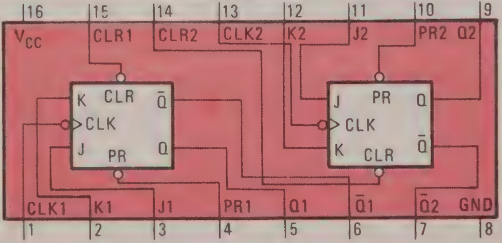
Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Maximum Low Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	2.0	V
		4.5V	4.5	V
		6.0V	6.0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V	4.2	V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V	5.7	V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	0	V
		4.5V	0	V
		6.0V	0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V	0.2	V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V	0.2	V
Max. Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0\ \mu A$	6.0V		µA

192 Popular Electronics FactCard

MM74HC112 • MM54HC112 • Dual J-K Flip-Flop with Preset and Clear

MM54HC112/MM74HC112



TRUTH TABLE

INPUTS					OUTPUTS	
PR	CLR	CLK	J	L	Q	Q̄
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	L*	L*
H	H	↓	L	L	Q0	Q̄0
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q0	Q0

*THIS IS AN UNSTABLE CONDITION', AND IS NOT GUARANTEED

GENERAL DESCRIPTION

These high speed (30 MHz minimum) J-K Flip-Flops utilize microCMOS Technology, 3.5-micron silicon gate, P-well CMOS to achieve the low power consumption and high noise immunity of standard CMOS integrated circuits, along with the ability to drive 10 LS-TTL loads.

Each flip-flop had independent J, K, PRESET, CLEAR, and CLOCK inputs and Q and Q̄ outputs. These devices are edge sensitive to the clock input and change state on the negative going transition of the clock pulse. Clear and preset are independent of the clock and accomplished by a low level on the corresponding input.

The 54HC/74HC logic family is functionally as well as pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

FEATURES

- Typical propagation delay: 16 ns
- Wide operating voltage range
- Low input current: 1 μA maximum
- Low quiescent current: 40 μA (74HC Series)
- High output drive: 10 LS-TTL loads

191 Popular Electronics **FactCard**

MM74HC109 • Dual J-K Flip-Flops
MM54HC109 • with Preset and Clear

DC ELECTRICAL CHARACTERISTICS

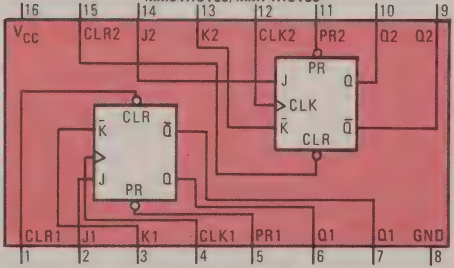
Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V 4.5V 6.0V		V V V
Maximum Low Level Input Voltage		2.0V 4.5V 6.0V		V V V
Minimum High Level Output Voltage	$V_{IN}=V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V 4.5V 6.0V	2.0 4.5 6.0	V V V
	$V_{IN}=V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V		V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V		V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Low Level Output Voltage	$V_{IN}=V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V 4.5V 6.0V	0 0 0	V V V
	$V_{IN}=V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V	0.2	V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V	0.2	V
Max. Input Current	$V_{IN}=V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current	$V_{IN}=V_{CC}$ or GND $I_{OUT}=0\ \mu A$	6.0V		µA

191 Popular Electronics **FactCard**

MM74HC109 · Dual J-K Flip-Flops
MM54HC109 · with Preset and Clear

MM54HC109/MM74HC109



TRUTH TABLE

INPUTS					OUTPUTS	
PR	CLR	CLK	J	$\bar{K}$	Q	$\bar{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↑	L	L	L	H
H	H	↑	H	L	TOGGLE	
H	H	↑	L	H	Q0	$\bar{Q}$0
H	H	↑	H	H	H	L
H	H	L	X	X	Q0	$\bar{Q}$0

GENERAL DESCRIPTION

These J-$\bar{K}$ Flip-Flops utilize microCMOS Technology, 3.5-micron silicon gate, P-well CMOS to achieve the low power consumption and high noise immunity of standard CMOS integrated circuits, along with the ability to drive 10 LS-TTL loads.

Each flip flop has independent J, $\bar{K}$, PRESET, CLEAR, and CLOCK inputs and Q and $\bar{Q}$ outputs. These devices are edge sensitive to the clock input and change state on the positive going transition of the clock pulse. Clear and preset are independent of the clock and accomplished by a low logic level on the corresponding input.

The 54HC/74HC logic family is functionally as well as pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

FEATURES

- Typical propagation delay: 20 ns
- Wide operating voltage range: 2-6V
- Low input current: 1 µA maximum
- Low quiescent current: 40 µA maximum (74HC Series)
- Output drive capability: 10 LS-TTL loads

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MM74HC107 · Dual J-K Flip-Flop
MM54HC107 · with Clear

DC ELECTRICAL CHARACTERISTICS

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Maximum Low Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \leq 20$ µA	2.0V	2.0	V
		4.5V	4.5	V
		6.0V	6.0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \leq 4.0$ mA	4.5V		V
	$\|I_{OUT}\| \leq 5.2$ mA	6.0V		V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \leq 20$ µA	2.0V	0	V
		4.5V	0	V
		6.0V	0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \leq 4.0$ mA	4.5V	0.2	V
	$\|I_{OUT}\| \leq 5.2$ mA	6.0V	0.2	V
Max. Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0$ µA	6.0V		µA

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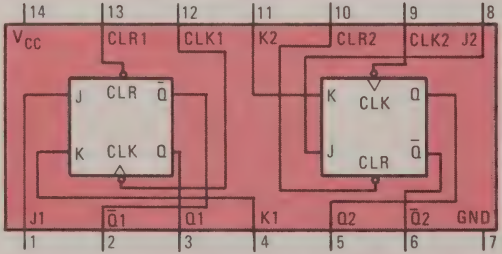
MM74HC107 · MM54HC107 · Dual J-K Flip-Flop with Clear

MM54HC107/MM74HC107



TRUTH TABLE

INPUTS				OUTPUTS	
CLR	CLK	J	K	Q	$\overline{Q}$
L	X	X	X	L	H
H	↓	L	L	Q_0	$\overline{Q}_0$
H	↓	H	L	H	L
H	↓	L	H	L	H
H	↓	H	H	TOGGLE	
H	H	X	X	Q_0	$\overline{Q}_0$

GENERAL DESCRIPTION

These J-K Flip-Flops utilize microCMOS Technology, 3.5-micron silicon gate, P-well CMOS to achieve, the high noise immunity and low power dissipation of standard CMOS integrated circuits. These devices can drive 10 LS-TTL loads.

These flip-flops are edge sensitive to the clock input and change state on the negative going transition of the clock pulse. Each one has independent, J, K, CLOCK, and CLEAR inputs and Q and $\overline{Q}$ outputs. CLEAR is independent of the clock and accomplished by a low level on the input.

The 54HC/74HC logic family is functionally as well as pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

FEATURES

- Typical propagation delay: 16 ns
- Wide operating voltage range: 2-6V
- Low input current: 1 µA maximum
- Low quiescent current: 40 µA maximum (74HC Series)
- High output drive: 10 LS-TTL loads

189 Popular Electronics FactCard MM74HC123A·Dual Retriggerable MM54HC123A·Monostable Multivibrator

DC ELECTRICAL CHARACTERISTICS

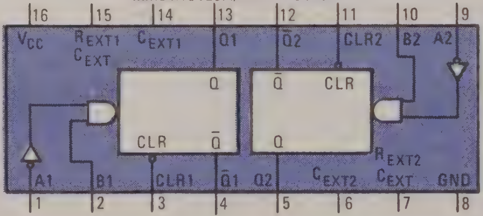
Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V 4.5V 6.0V		V V V
Maximum Low Level Input Voltage		2.0V 4.5V 6.0V		V V V
Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT} \rvert \leq 20\ \mu A$	2.0V 4.5V 6.0V	2.0 4.5 6.0	V V V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT} \rvert \leq 4.0$ mA $\lvert I_{OUT} \rvert \leq 5.2$ mA	4.5V 6.0V	4.2 5.7	V V
Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT} \rvert \leq 20\ \mu A$	2.0V 4.5V 6.0V	0 0 0	V V V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT} \rvert \leq 4.0$ mA $\lvert I_{OUT} \rvert \leq 5.2$ mA	4.5V 6.0V	0.2 0.2	V V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Input Current (Pins 7, 15)	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Input Current (all other pins)	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current (standby)	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0\ \mu A$	6.0V		µA
Maximum Active Supply Current (per monostable)	$V_{IN} = V_{CC}$ or GND $R/C_{EXT} = 0.5V_{CC}$	2.0V 4.5V 6.0V	36 0.33 0.7V	µA mA mA

189 Popular Electronics FactCard

MM74HC123A-Dual Retriggerable MM54HC123A-Monostable Multivibrator

MM54HC123A/MM74HC123A



TRUTH TABLE

INPUTS			OUTPUTS	
CLEAR	A	B	Q	$\overline{Q}$
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	⎍	⊔
H	↓	H	⎍	⊔
↑	L	H	⎍	⊔

H = HIGH LEVEL
L = LOW LEVEL
↑ = TRANSITION FROM LOW TO HIGH
↓ = TRANSITION FROM HIGH TO LOW
⎍ = ONE HIGH LEVEL PULSE
⊔ = ONE LOW LEVEL PULSE
X = IRRELEVANT

GENERAL DESCRIPTION

The MM54/74HC123A high speed monostable multivibrators (one shots) utilize microCMOS Technology, 3.5-micron silicon gate, P-well CMOS. They feature speeds comparable to low power Schottky TTL circuitry while retaining the low power and high noise immunity characteristics of CMOS circuits.

Each multivibrator features both a negative, A, and a positive, B, transition-triggered input, either of which can be used as an inhibit input. Also included is a clear input that when taken low resets the one shot. The 'HC123 can be triggered on the positive transition of the clear while A is held low and B is held high.

The 'HC123A is retriggerable. That is it may be triggered repeatedly while their outputs are generating a pulse and the pulse will be extended.

Pulse width stability over a wide range of temperature and supply is achieved using linear CMOS techniques. The output pulse equation is simply: $PW = (R_{EXT})(C_{EXT})$; where PW is in secons, R is in ohms, and C is in farads. All inputs are protected from damage due to static discharge by diodes to V_{CC} and ground.

188 Popular Electronics FactCard

MM74HC85 · MM54HC85 · 4-Bit Magnitude Comparator

DC ELECTRICAL CHARACTERISTICS

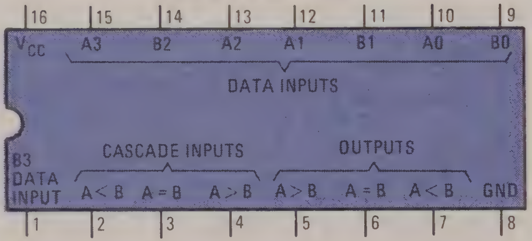
Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Maximum Low Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \le 20\ \mu A$	2.0V	2.0	V
		4.5V	4.5	V
		6.0V	6.0	V
	$V_{IN} = V_{IH}$ or V_{IL}			
	$\|I_{OUT}\| \le 4.0$ mA	4.5V	4.2	V
	$\|I_{OUT}\| \le 5.2$ mA	6.0V	5.7	V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\|I_{OUT}\| \le 20\ \mu A$	2.0V	0	V
		4.5V	0	V
		6.0V	0	V
	$V_{IN} = V_{IH}$ or V_{IL}			
	$\|I_{OUT}\| \le 4.0$ mA	4.5V	0.2	V
	$\|I_{OUT}\| \le 5.2$ mA	6.0V	0.2	V
Max. Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0\ \mu A$	6.0V		µA

188 Popular Electronics FactCard

MM74HC85 MM54HC85 : 4-Bit Magnitude Comparator

MM54HC85/MM74HC85



FEATURES

- Typical propagation delay: 27 ns
- Wide operating voltage range: 2-6V
- Low input current: 1 μA maximum
- Low quiescent current: 80 μA maximum (74HC Series)
- Output drive capability: 10 LS-TTL loads

GENERAL DESCRIPTION

The MM54HC85/MM74HC85 is a 4-bit magnitude comparator that utilizes microCMOS Technology, 3.5-micron silicon gate, P-well CMOS. It is designed for high speed comparison of two four bit words. This circuit has eight comparison inputs, 4 for each word; three cascade inputs (A<B, A>B, A = B); and three decision outputs (A<B, A>B, A = B). The result of a comparison is indicated by a high level on one of the decision outputs. Thus it may be determined whether one word is "greater than," "less than," or "equal to" the other word. By connecting the outputs of the least significant stage to the cascade inputs of the next stage, words of greater than four bits can be compared. In addition the least significant stage must have a high level applied to the A = B input, and a low level to the A<B, and A>B inputs.

The comparator's outputs can drive 10 low power Schottky TTL (LS-TTL) equivalent loads, and is functionally, and pin equivalent to the 54LS85/74LS85. All inputs are protected from damage due to static discharge by diodes to V_{CC} and ground.

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MM74HC86 MM54HC86 : Quad 2-Input Exclusive OR Gate

DC ELECTRICAL CHARACTERISTICS

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Minimum High Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Maximum Low Level Input Voltage		2.0V		V
		4.5V		V
		6.0V		V
Minimum High Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	2.0	V
		4.5V	4.5	V
		6.0V	6.0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V	4.2	V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V	5.7	V

Parameter	Conditions	V_{CC}	T_A 25°C Typ	Units
Maximum Low Level Output Voltage	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	0	V
		4.5V	0	V
		6.0V	0	V
	$V_{IN} = V_{IH}$ or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	4.5V	0.2	V
	$\lvert I_{OUT}\rvert \le 5.2$ mA	6.0V	0.2	V
Max. Input Current	$V_{IN} = V_{CC}$ or GND	6.0V		µA
Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0\ \mu A$	6.0V		µA

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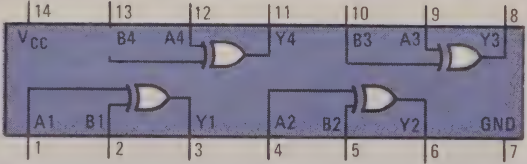
MM74HC86 MM54HC86 ▪ Quad 2-Input Exclusive OR Gate

MM54HC86/MM74HC86



TRUTH TABLE

INPUTS		OUTPUTS
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

$Y = A \quad B = \bar{A}B + A\bar{B}$

GENERAL DESCRIPTION

This EXCLUSIVE OR gate utilizes microCMOS Technology, 3.5-micron silicon gate, P-well CMOS to achieve operating speeds similar to equivalent LS-TTL gates while maintaining the low power consumption and high noise immunity characteristic of standard CMOS integrated circuits. These gates are fully buffered and have a fanout of 10 LS-TTL loads. The MM54HC/74HC logic family is functionally as well as pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

FEATURES

- Typical propagation delay: 9 ns
- Wide operating voltage range: 2-6V
- Low input current: 1 μA maximum
- Low quiescent current: 20 μA maximum (74 Series)
- Output drive capability: 10 LS-TTL loads

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CD4529: Dual 4-Channel or Single 8-Channel Analog Data Selector

DC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	25°C TYP	UNITS
Quiescent Device Current	$V_{DD} = 5V$	0.001	µA
	$V_{DD} = 10V$	0.002	µA
	$V_{DD} = 15V$	0.003	µA
Low Level Output Voltage	$V_{DD} = 5V$	0	V
	$V_{DD} = 10V$	0	V
	$V_{DD} = 15V$	0	V
High Level Output Voltage	$V_{DD} = 5V$	5.0	V
	$V_{DD} = 10V$	10.0	V
	$V_{DD} = 15V$	15.0	V
Low Level Input Voltage	$V_{DD} = 5V$	2.25	V
	$V_{DD} = 10V$	4.50	V
	$V_{DD} = 15V$	6.75	V
High Level Input Voltage	$V_{DD} = 5V$	2.75	V
	$V_{DD} = 10V$	5.50	V
	$V_{DD} = 15V$	8.25	V
Input Current	$V_{DD} = 15V$		
	$V_{IN} = 0V$	-10^{-5}	µA
	$V_{IN} = 15V$	10^{-5}	µA

PARAMETER	CONDITIONS	25°C TYP	UNITS
ON Resistance	$V_{IN} = 5V$	165	Ω
	$V_{IN} = -5V$	100	Ω
	$V_{IN} = \pm 0.25V$	155	Ω
	$V_{IN} = 7.5V$	135	Ω
	$V_{IN} = -7.5V$	75	Ω
	$V_{IN} = \pm 0.25V$	100	Ω
	$V_{IN} = 10V$	165	Ω
	$V_{IN} = 0.25V$	100	Ω
	$V_{IN} = 5.6V$	160	Ω
	$V_{IN} = 15V$	135	Ω
	$V_{IN} = 0,25V$	75	Ω
	$V_{IN} = 9.3V$	110	Ω
Input to Output Leakage Current	$V_{SS} = -5V$ $V_{OUT} = -5V$	±0.001	nA
	$V_{SS} = -5V$ $V_{OUT} = 5V$	±0.001	nA
	$V_{SS} = -7.5V$ $V_{OUT} = -7.5V$	±0.0015	nA
	$V_{SS} = -7.5V$ $V_{IN} = -7.5V$	±0.0015	nA

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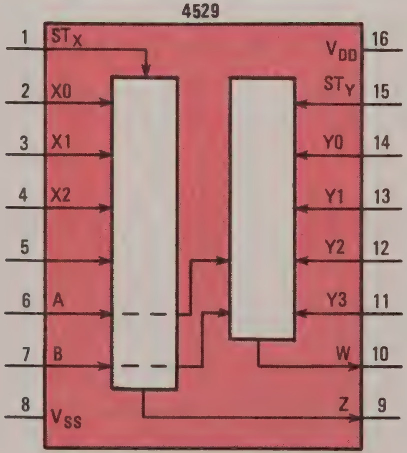
CD4529: Dual 4-Channel or Single 8-Channel Analog Data Selector



GENERAL DESCRIPTION

The CD4529B is a dual 4-channel or a single 8-channel analog data selector, implemented with complementary MOS (CMOS) cicuits constructed with N- and P-channel enhancement mode transistors. Dual 4-channel or 8-channel mode operation is selected by proper input coding, with outputs Z and W tied together for the single 8-bit mode. The device is suitable for digital as well as analog applications, including various 1-of-4 and 1-of-8 data selector functions. Since the device is analog and bidirectional, it can also be used for dual binary to 1-of-4 or single 1-of-8 decoder applications.

FEATURES

■ Wide supply voltage range	3.0V to 15V
■ High noise immunity	0.45V_{DD} (typ.)
■ Low quiescent power dissipation	0.005 μW/package (typ.) @ 5.0 V_{DC}
■ 10 MHz frequency operation (typ.)	
■ Data paths are bidirectional	
■ Linear ON resistance [120 Ω (typ.) @ 15V]	
■ TRI-STATE® outputs (high impedance disable strobe)	
■ Plug-in replacement for MC14529B	

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CD4514 : 4-Bit Latched/4-to-16
CD4515 : Line Decoders

DC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	25°C TYP	UNITS
Quiescent Device Current	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	0.005 0.010 0.015	μA μA μA
Low Level Output Voltage	$V_{IH} = V_{DD}$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	 0 0 0	 V V V
High Level Output Voltage	$V_{IH} = V_{DD}$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	 5.0 10.0 15.0	 V V V
Low Level Input Voltage	$V_O = 0.05V$ $V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	 2.25 4.50 6.75	 V V V

PARAMETER	CONDITIONS	25°C TYP	UNITS
High Level Input Voltage	$V_O = 0.5V$ $V_{[} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	 2.75 5.50 8.25	 V V V
Low Level Output Current	$V_{DD} = 15V$ $V_{IN} = 10V$ $V_{IN} = 15V$	0.88 2.25 8.80	mA mA mA
High Level Output Current	$V_{DD} = 5V$ $V_{IN} = 10V$ $V_{IN} = 15V$	−0.88 −2.25 −8.80	mA mA mA
Input Current	$V_{DD} = 15V$ $V_{DD} = 15V$	-10^{-5} 10^{-5}	μA μA

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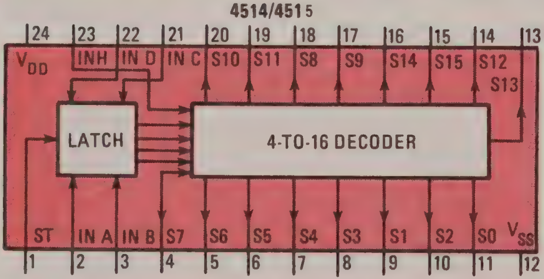
CD4514 · 4-Bit Latched/4-to-16
CD4515 · Line Decoders



FEATURES

■ Wide supply voltage range	3.0V to 15V
■ High noise immunity	$0.45V_{DD}$ (typ.)
■ Low power TTL compatibility	fan out of 2 driving 74L
■ Low quiescent power dissipation	0.025 μW/package @ 5.0 V_{DC}

- Single supply operation
- Input impedance = 10^{12} Ω typically
- Plug-in replacement for MC14514, MC14515

GENERAL DESCRIPTION

The CD4514B and CD4515B are 4-to 16 line decoders with latched inputs implemented with complementary MOS (CMOS) circuits constructed with N- and P-channel enhancement mode transistors. These circuits are primarily used in decoding applications where low power dissipation and/or high noise immunity is required. The CD4514B (output active high option) presents a logical "1" at the selected output, whereas the CD4515B presents a logical "0" at the selected output. The input latches are R-S type flip-flops, which hold the last input data presented prior to the strobe transition from "1" to "0". This input data is decoded and the corresponding output is activated. An output inhibit line is also available.

ABSOLUTE MAXIMUM RATINGS

V_{DD} DC Supply Voltage	−0.5V to +18V
V_{IN} Input Voltage	−0.5V to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	260°C

RECOMMENDED OPERATING CONDITION

V_{DD} DC Supply Voltage	3V to 15V
V_{IN} Input Voltage	0 to V_{DD}
T_A Operating Temperature Range	
CD45148BM, CD451BM	−55°C to +125°C
CD4514BC, CD4515BC	−40°C to +85°C

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CD4510 · BCD Up/Down Counter
CD4516 · Binary Up/Down Counter

ABSOLUTE MAXIMUM RATINGS

V_{DD} dc Supply Voltage	−0.5V to +18V
V_{IN} Input Voltage	−0.5V to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mQ
T_L Lead Temperature (Soldering, 10 seconds)	260°C

RECOMMENDED OPERATING CONDITION

V_{DD} dc Supply Voltage	3V to 15
V_{IN} Input Voltage	0 to V_{DD}
T_A Operating Temperature Range	
CD4510BM, CD416BM	−55°C to +125°
CD4510BC, CD4516BC	−40°C to +85°

DC ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	25°C TYP	UNITS
Quiescent Device Current	$V_{DD}=5V$	0.05	μA
	$V_{DD}=10V$	0.1	μA
	$V_{DD}=15V$	0.15	μA
Low Level Output Voltage	$V_{IH}=V_{DD}$		
	$V_{DD}=5V$	0	V
	$V_{DD}=10V$	0	V
	$V_{DD}=15V$	0	V
High Level Output Voltage	$V_{IH}=V_{DD}$		
	$V_{DD}=5V$	5	V
	$V_{DD}=10V$	10	V
	$V_{DD}=15V$	15	V
Low Level Input Voltage	$\lvert I_O \rvert<1$ μA		
	$V_{DD}=5V$	2.25	V
	$V_{DD}=10V$	4.5	V
	$V_{DD}=15V$	6.75	V
High Level Input Voltage	$\lvert I_O \rvert 1$ μA		
	$V_{DD}=5V$	2.75	V
	$V_{DD}=10V$	5.5	V
	$V_{DD}=15V$	8.25	V
Low Level Output Current	$V_{IH}=V_{DD}$		
	$V_{DD}=5V$	0.8	mA
	$V_{DD}=10V$	2.0	mA
	$V_{DD}=15V$	7.8	mA
High Level Output Current	$V_{IH}=V_{DD}$		
	$V_{DD}=5V$	−0.8	mA
	$V_{DD}=10V$	−2.0	mA
	$V_{DD}=15V$	−7.8	mA
Input Current	$V_{DD}=15V$	-10^{-5}	μA
	$V_{DD}=15V$	10^{-5}	μA

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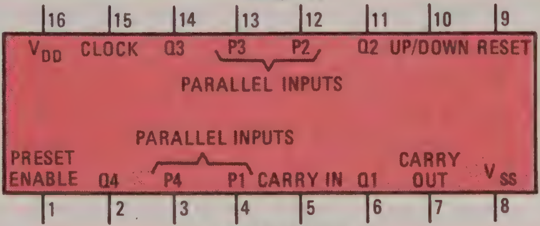
CD4510 : BCD Up/Down Counter
CD4516 : Binary Up/Down Counter

4510/4516



TRUTH TABLE

CLOCK	RESET	PRESET ENABLE	CARRY IN	UP/DOWN	OUTPUT FUNCTION
X	1	X	X	X	RESET TO ZERO
X	0	1	X	X	SET TO P1, P2, P3, P4
↑	0	0	0	1	COUNT UP
↑	0	0	0	0	COUNT DOWN
↓	0	0	X	X	NO CHANGE
X	0	0	1	X	NO CHANGE

↑ = POSITIVE TRANSITION ↓ = NEGATIVE TRANSITION
X = DON'T

GENERAL DESCRIPTION

The CD4510BM/CD4516BC and CD4516BM/CD4516BC are monolithic CMOS up/down counters which count in BCD and binary, respectively.

The counters count up when the up/down input is at logical "1" and vice versa. A logical "1" preset enable signal allows information at the parallel inputs to preset the counters to any state synchronously with the clock. The counters are advanced one count at the positive-going edge of the clock if the carry in, preset enable, and reset inputs are at logical "0". Advancement is inhibited when any of these three inputs are at logical "1". The carry out signal is normally at logical "1" state and goes to logical"0" when the counter reaches its maximum count in the "up" mode or its minimum count in the "down" mode, provided the carry input is at logical "0" state. The counters are cleared asynchronously by applying a logical "1" voltage level at the reset input.

All inputs are protected against static discharge by diode clamps to both V_{DD} and V_{SS}.

FEATURES

■ Wide supply voltage range	3.0V to 15V
■ High noise immunity	$0.45V_{DD}$(typ.)
■ Low power TTL compatibility	fan out of 2 driving 74L or 1 driving 74LS
■ Parallel load "jam" inputs	
■ Low quiescent power dissipation	0.25 μW/package (typ.) @ $V_{CC} = 5.0V$
■ Motorola MC14510, MC14516 second source	

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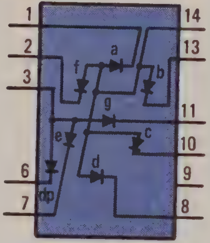
FUNCTIONAL BLOCK DIAGRAMS



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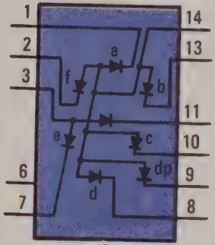

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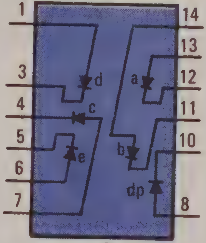

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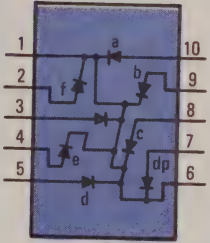

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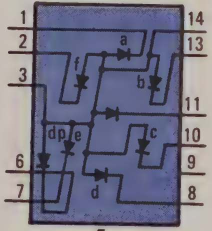

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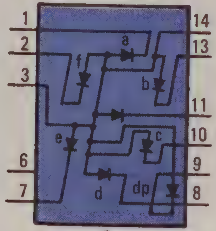

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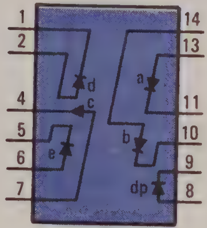

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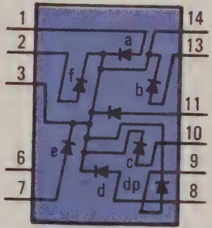

H

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Device	Description	Outline
7730	Common Anode Left Hand Decimal	A
7731	Common Anode Right Hand Decimal	B
7736	Universal Overflow ± 1 Right Hand Decimal	C
7740	Common Cathode Right Hand Decimal	D
7750	Common Anode Left Hand Decimal	E
7751	Common Anode Right Hand Decimal	F
7756	Universal Overflow ± 1 Right Hand Decimal	G
7760	Common Cathode Right Hand Decimal	H

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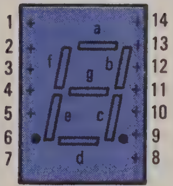
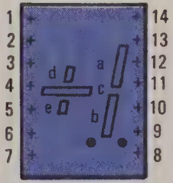
5082-7730/5082-7740 5082-7750/5082-7760 • 7-Segment Displays

PINOUT DIAGRAMS



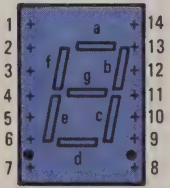
R,H,D,P

A, B, D



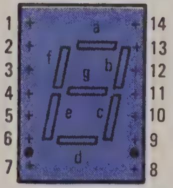
R,H,D,P

C



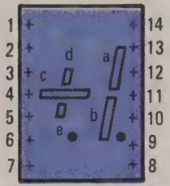
L,H,D,P

E



F, H

R,H,D,P



G

R,H,D,P

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5082-7730/5082-7740 · 5082-7750/5082-7760 · 7-Segment Displays

GENERAL DESCRIPTION

The 5082-7730/7740 series and 5082-7750/7760 series displays are 7.62/10.92 mm (0.3/0.43 in) high red LED displays. The 7730/7740 series devices are designed for viewing distances of up to three meters and the 7750/7760 series devices are designed for viewing distances of up to six meters. These displays are designed for use in instruments, point of sale terminals, clocks and appliances. These devices use LED die made with GaAsP on a GaAs substrate and are composed of eight light emitting diodes, with the light from each LED optically stretched to form individual segments and a decimal point. These displays are designed for strobed operation at high peak currents.

FEATURES

- EXCELLENT CHARACTER APPEARANCE
  Continuous Uniform Segments
  Wide Viewing Angle
  HIgh Contrast
- IC COMPATIBLE
  1.6V DC per Segment
- STANDARD 0.3" DIP LEAD CONFIGURATION
  PC Board or Standard Socket Mountable
- CATEGORIZED FOR LUMINOUS INTENSITY
  Assures Uniformity of Light Output from Unit to Unit within a Single Category
- MECHANICALLY RUGGED

ELECTRICAL 5082-77XX

The 5082-77XX series of display devices are composed of eight light emitting diodes, with the light from each LED optically stretched to form individual segments and a decimal point. The LEDs have the P-N junction diffused into a GaAsP epitaxial layer on a GaAs substrate.

These display devices are designed for strobed operation at high peak currents. The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum V_F values for the purpose of driver circuit design may be calculated using the following V_F model:

$$V_F = 1.55\text{V} + I_{PEAK}\,(7\Omega)$$
$$\text{For } 5\text{mA} \le I_{PEAK} \le 150\text{mA}$$

CONTRAST ENHANCEMENT

The 5082-77XX series display may be effectively filtered using one of the following filter products: Homalite H100-1605: H 100-804 (purple); Panelgraphic Ruby Red 60: Dark Red 63; Purple 90; Plexiglass 2423; Brand Light Control Film for daylight viewing.

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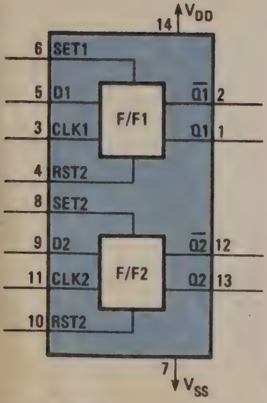
CMOS IC's: 4013



4013 (D flip-flop)

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	V_{DD} (V)	LIMITS		UNITS
		MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range)	—	3	18	V
Data Setup Time	5	40	—	ns
	10	20	—	
	15	15	—	
Clock Pulse Width	5	140	—	ns
	10	60	—	
	15	40	—	
Clock Input Frequency	5	DC	3.5	MHz
	10		8	
	15		12	
Clock Rise or Fall Time	5	—	15	µs
	10	—	4	
	15	—	1	
Set or Reset Pulse Width	5	180	—	ns
	10	80	—	
	15	50	—	

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CMOS IC's: 4013

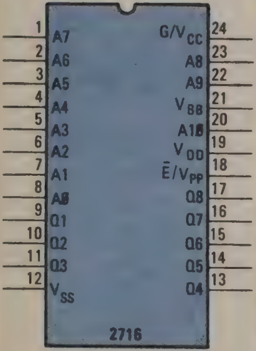
STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.02	µA
	—	0,10	10	0.02	
	—	0,15	15	0.02	
	—	0,20	20	0.04	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage: Low Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	1.5	V
	1,9	—	10	3	
	1.5,13.5	—	15	4	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	3.5	
	1,9	—	10	7	
	1.5,13.5	—	15	11	

32 Hands-on Electronics FactCard

EPROM's: 2716



RECOMMENDED OPERATING CONDITIONS

PARAMETER	MIN	NOM	MAX	UNIT
V_{BB}	−4.75	−5	−5.25	V
V_{CC}	4.75	5	5.25	V
V_{DD}	11.4	12	12.6	V
V_{SS}		0		V
V_{IH} (except program and program enable)	2.4		$V_{CC}+1$	V
$V_{IH(G)}$	11.4	12	12.6	V
$V_{IH(E)}$	25	26	27	V
V_{IL} (except program)	V_{SS}		0.65	V
$V_{IL(E)}$	V_{SS}		1	V
$I_{IH\ (E)}$			40	mA
$I_{IL\ (E)}$			3	mA
Operating free-air temperature, T_A	0	–	70	°C

ELECTRICAL CHARACTERISTICS

PARAMETER	MIN	TYP	MAX	UNITS
V_{OH}	2.4			V
V_{OL}			0.45	V
I_I (leakage)		1	10	µA
I_O (leakage)		1	10	µA
I_{BB}		10	20	mA
I_{CC}		1	8	mA
I_{DD}		26	45	mA
I_G		2	4	mA

See *FactCard 31* for EPROM timing and signal definitions.

32 Hands-on Electronics FactCard

EPROM's: 2716

SWITCHING CHARACTERISTICS

PARAMETER	MIN	MAX	UNIT
$t_a(A)$		450	ns
$t_{en}(G)$		120	ns
$t_v(A)$	0		ns
t_{dis}	0	120	ns
Read Cycle time	450		ns

ABSOLUTE MAXIMUM RATINGS

V_{CC}	−0.3 to 15V
V_{DD}	−0.3 to 20V
V_{SS}	−0.3 to 15V
All input voltage (except V_{PP})	−0.3 to 20V
V_{PP}	−0.3 to 35V
Output voltage (operating, with respect to V_{SS})	−2 to 7V
Operating free-air tempertaure range	0°C to 70°C
Storage temperature range	−55°C to 125°C

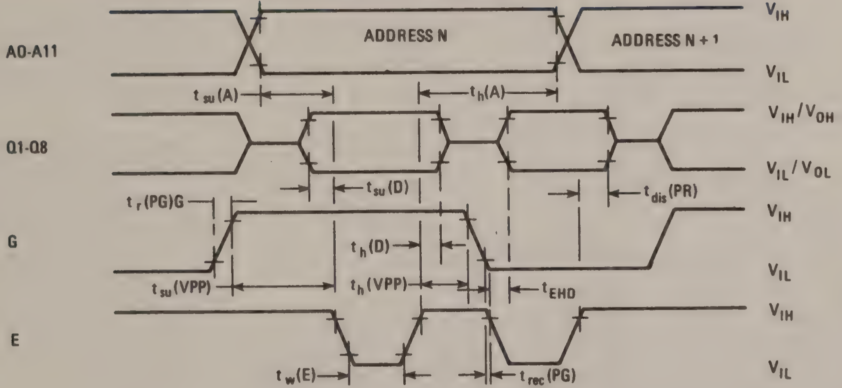
PROGRAM CHARACTERISTICS

PARAMETER	MIN	MAX	UNIT
$t_w(E)$	0.1	1	ms
Transition times (except program pulse)		20	ns
Transition times, program pulse	50	2000	ns
$t_{su}(A)$	10		µs
$t_{su}(D)$	10		µs
$t_{su}(V_{pp})$	10		µs
$t_h(A)$	1000		ns
Address hold time after program input data stopped	0		ns
$t_h(D)$	1000		ns
$t_h(V_{pp})$	500		ns
t_{EHD}	0		ns

31 **Hands-on Electronics FactCard**

EPROM Timing

PROGRAM CYCLE TIMING



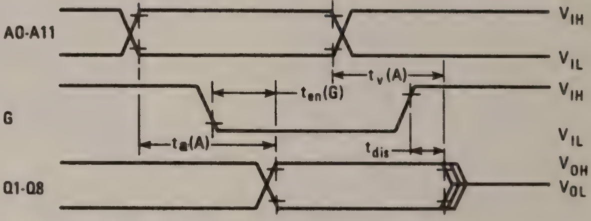
31 Hands-on Electronics FactCard

EPROM Timing

EPROM DATA DEFINITIONS

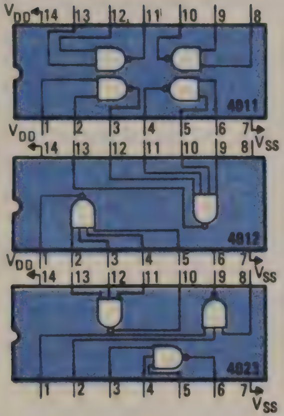
V_{PP}	Programming voltage
V_{IH}	High-level input voltage
V_{IL}	Low-level input voltage
V_{OH}	High-level output voltage (verify)
V_{OL}	Low-level output voltage (verify)
I_I	Input current (all inputs)
I_{IH}	High-level input current
I_{IL}	Low-level input current
$t_{dis}(PR)$	Output disable time
$t_w(E)$	E pulse duration
$t_{su}(A)$	Address setup time
$t_{su}(D)$	Data setup time
$t_{su}(V_{PP})$	Vpp setup time
$t_h(A)$	Address hold time
$t_h(D)$	Data hold time
$t_h(V_{PP})$	Vpp hold time

READ CYCLE TIMING



$t_{rec}(PG)$	Vpp recovery time	t_{dis}	Output disable time from E or G, whichever occurs first
$t_r(PG)G$	G rise time during programming		
t_{EHD}	Delay time, data valid after E low	$t_v(A)$	Output data valid time after change of address, E, or G, whichever occurs first
$t_a(A)$	Access time from address		
$t_a(E)$	Access time from E	E	Program pulse
$t_{en}(G)$	Output enable time from G	G	Program enable

30 Hands-on Electronics FactCard | CMOS IC's: 4011, 4012, 4023



MAXIMUM RATINGS *(Absolute-Maximum Values)*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal) . . . . -0.5 to $+20$V
INPUT VOLTAGE RANGE, ALL INPUTS . . . . -0.5 to V_{DD} $+0.5$V
DC INPUT CURRENT, ANY ONE INPUT . . . . ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = -40 to $+60$°C (PACKAGE TYPE E) . . . . 500 mW
For T_A = $+60$ to $+85$°C (PACKAGE TYPE E) Derate Linearly at 12 mW/°C to 200 mW
For T_A = -55 to $+100$°C (PACKAGE TYPES D,F) . . . . 500 mW
For T_A = $+100$ to $+125$°C (PACKAGE TYPES D,F) Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100 mW
OPERATING-TEMPERATURE RANGE (T_A):
PACKAGE TYPES D,F,H . . . . -55 to $+125$°C
PACKAGE TYPE E . . . . -40 to $+85$°C
STORAGE TEMPERATURE RANGE (T_{stg}) . . . . -65 to $+150$°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10s max . . . . . . $+265$°C

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range)	3	18	V

30 Hands-on Electronics FactCard

CMOS IC's: 4011, 4012, 4023

STATIC ELECTRICAL CHARACTERISTICS

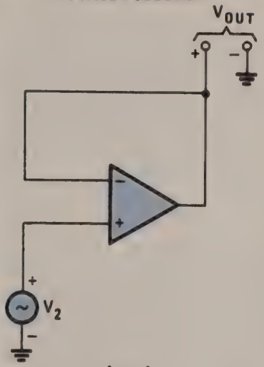
CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.01	µA
	—	0,10	10	0.01	
	—	0,15	15	0.01	
	—	0,20	20	0.02	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage: Low Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	4.5	—	5	1.5	V
	9	—	10	3	
	13.5	—	15	4	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	3.5	
	1,9	—	10	7	
	1.5,13.5	—	15	11	

29 Hands-on Electronics FactCard

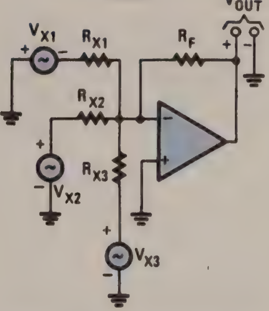
Op-Amp Circuits

VOLTAGE FOLLOWER



$A_V = 1$

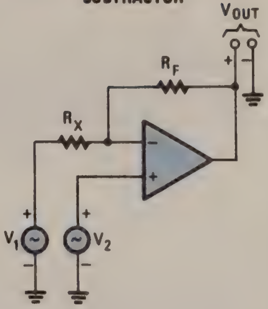
ADDER



$$V_{OUT} = -\frac{R_F}{R_X}(V_{X1} + V_{X2} + V_{X3})$$

$$(R_{X1} = R_{X2} = R_{X3})$$

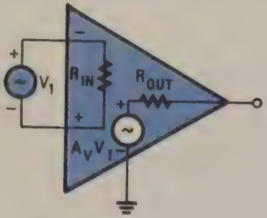
SUBTRACTOR



$$V_{OUT} = V_2 + \frac{R_F}{R_X}(V_2 - V_1)$$

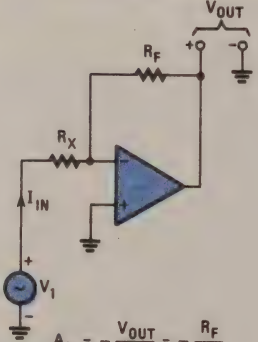
Op-Amp Circuits

IDEAL OP-AMP



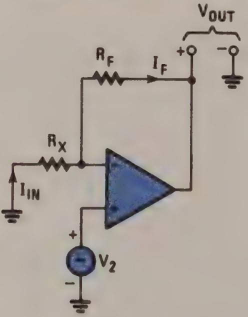
$R_{IN} = \infty$
$R_{OUT} = 0$
$A_V = \infty$
BANDWIDTH = ∞
RESPONSE TIME = 0

INVERTING AMPLIFIER



$$A_V = -\frac{V_{OUT}}{V_1} = -\frac{R_F}{R_X}$$

NON-INVERTING AMPLIFIER

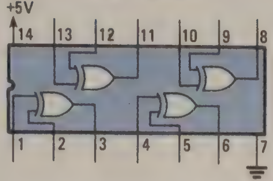


$$A_V = \frac{V_{OUT}}{V_2} = \frac{R_F}{R_X} + 1$$

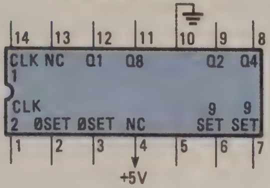
28 Hands-on Electronics FactCard

TTL IC's: 7486, 7489, 7490 7492, 7493, 7495

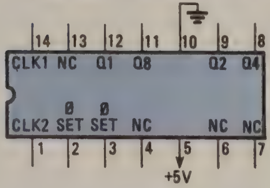
7486 QUAD XOR



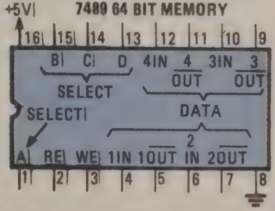
7490 DECADE COUNTER



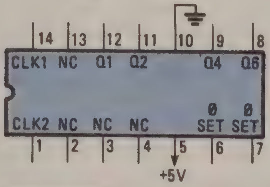
7493 BINARY (÷16) COUNTER



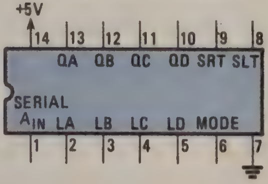
7489 64 BIT MEMORY



7492 ÷12 COUNTER

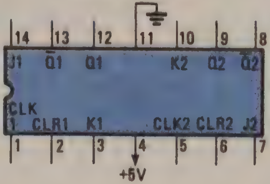


7495 4-BIT SHIFT REGISTER

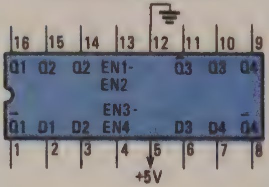


TTL IC's: 7473, 7474, 7475 7476, 7483, 7485

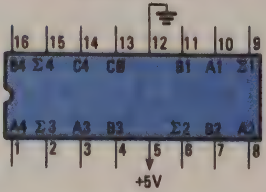
7473 JK FLIP-FLOP



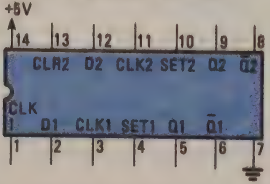
7475 QUAD D FLIP-FLOP



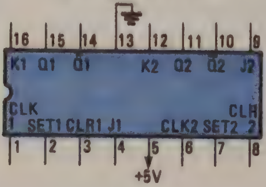
7483 4-BIT ADDER



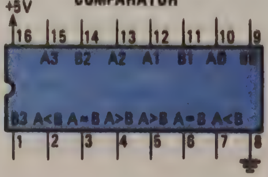
7474 DUAL D FLIP-FLOP



7476 DUAL JK FLIP-FLOP



7485 4-BIT MAGNITUDE COMPARATOR



27 Hands-on Electronics FactCard

dB Conversion Table

dB	Current or Voltage Ratio	
	Gain	Loss
13.3	4.624	.2163
13.4	4.677	.2138
13.5	4.732	.2113
13.6	4.786	.2089
13.7	4.842	.2065
13.8	4.898	.2042
13.9	4.955	.2018
14.0	5.012	.1995
14.1	5.070	.1972
14.2	5.129	.1950
14.3	5.188	.1928
14.4	5.248	.1905
14.5	5.309	.1884
14.6	5.370	.1862
14.7	5.433	.1841
14.8	5.495	.1820
14.9	5.559	.1799
15.0	5.623	.1778
15.1	5.689	.1758
15.2	5.754	.1738
15.3	5.821	.1718
15.4	5.888	.1698
15.5	5.957	.1679
15.6	6.026	.1660
15.7	6.095	.1641
15.8	6.166	.1622
15.9	6.237	.1603
16.0	6.310	.1585
16.1	6.383	.1567
16.2	6.457	.1549
16.3	6.531	.1531
16.4	6.607	.1514
16.5	6.683	.1496
16.6	6.761	.1479
16.7	6.839	.1462
16.8	6.918	.1445
16.9	6.998	.1429
17.0	7.079	.1413
17.1	7.161	.1396
17.2	7.244	.1380
17.3	7.328	.1365
17.4	7.413	.1349
17.5	7.499	.1334
17.6	7.586	.1318
17.7	7.674	.1303
17.8	7.762	.1288
17.9	7.852	.1274
18.0	7.943	.1259
18.1	8.035	.1245
18.2	8.128	.1230
18.3	8.222	.1216
18.4	8.318	.1202
18.5	8.414	.1189
18.6	8.511	.1175
18.7	8.610	.1161
18.8	8.710	.1148
18.9	8.811	.1135
19.0	8.913	.1122
19.1	9.016	.1109
19.2	9.120	.1096
19.3	9.226	.1084
19.4	9.333	.1072
19.5	9.441	.1059
19.6	9.550	.1047

27 Hands-on Electronics FactCard

dB Conversion Table

dB	Current or Voltage Ratio	
	Gain	Loss
19.7	9.661	.1035
19.8	9.772	.1023
19.9	9.886	.1012
20.0	10.00	0.1000
25.0	17.78	0.0562
30.0	31.62	0.0316
35.0	56.23	0.0178
40.0	100.00	0.0100
45.0	177.8	0.0056
50.0	316.2	0.0032
55.0	562.3	0.0018
60.0	10^3	10^{-3}
65.0	1.778×10^3	5.623×10^{-4}
70.0	3.162×10^3	3.162×10^{-4}

dB	Current or Voltage Ratio	
	Gain	Loss
75.0	5.623×10^3	1.78×10^{-4}
80.0	10^4	10^{-4}
85.0	1.778×10^4	5.623×10^{-5}
90.0	3.162×10^4	3.162×10^{-5}
95.0	5.632×10^4	1.78×10^{-5}
100.0	10^5	10^{-5}
110.0	3.162×10^5	3.162×10^{-6}
120.0	10^6	10^{-6}
130.0	3.162×10^6	3.162×10^{-7}
140.0	10^7	10^{-7}
150.0	3.162×10^7	3.162×10^{-8}
160.0	10^8	10^{-8}
170.0	3.162×10^8	3.162×10^{-9}
180.0	10^9	10^{-9}

$$V(\mathrm{dB}) = 20\ \mathrm{LOG}_{10} \frac{V_{OUT}}{V_{IN}}$$

$$I(\mathrm{dB}) = 20\ \mathrm{LOG}_{10} \frac{I_{OUT}}{I_{IN}}$$

26 Hands-on Electronics FactCard

dB Conversion Table

dB	Current or Voltage Ratio		dB	Current or Voltage Ratio		dB	Current or Voltage Ratio	
	Gain	Loss		Gain	Loss		Gain	Loss
0	1.000	1.000	2.2	1.288	.7762	4.4	1.660	.6026
.1	1.012	.9886	2.3	1.303	.7674	4.5	1.679	.5957
.2	1.023	.9772	2.4	1.318	.7586	4.6	1.698	.5888
.3	1.035	.9661	2.5	1.334	.7499	4.7	1.718	.5821
.4	1.047	.9550	2.6	1.349	.7413	4.8	1.738	.5754
.5	1.059	.9441	2.7	1.365	.7328	4.9	1.758	.5689
.6	1.072	.9333	2.8	1.380	.7244	5.0	1.778	.5623
.7	1.084	.9226	2.9	1.396	.7161	5.1	1.799	.5559
.8	1.096	.9120	3.0	1.413	.7079	5.2	1.820	.5495
.9	1.109	.9016	3.1	1.429	.6998	5.3	1.841	.5433
1.0	1.122	.8913	3.2	1.445	.6918	5.4	1.862	.5370
1.1	1.135	.8810	3.3	1.462	.6839	5.5	1.884	.5309
1.2	1.148	.8710	3.4	1.479	.6761	5.6	1.905	.5248
1.3	1.161	.8610	3.5	1.496	.6683	5.7	1.928	.5188
1.4	1.175	.8511	3.6	1.514	.6607	5.8	1.950	.5129
1.5	1.189	.8414	3.7	1.531	.6531	5.9	1.972	.5070
1.6	1.202	.8318	3.8	1.549	.6457	6.0	1.995	.5012
1.7	1.216	.8222	4.9	1.567	.6383	6.1	2.018	.4955
1.8	1.230	.8128	4.0	1.585	.6310	6.2	2.042	.4898
1.9	1.245	.8035	4.1	1.603	.6237	6.3	2.065	.4842
2.0	1.259	.7943	4.2	1.622	.6166	6.4	2.089	.4786
2.1	1.274	.7852	4.3	1.641	.6095	6.5	2.113	.4732

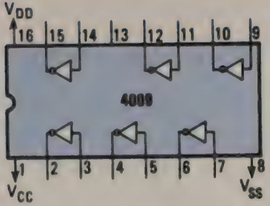
26 **Hands-on Electronics** FactCard

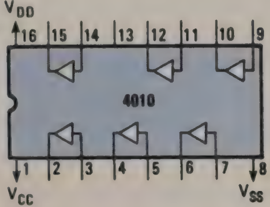
dB Conversion Table

dB	Current or Voltage Ratio	
	Gain	Loss
6.6	2.138	.4677
6.7	2.163	.4624
6.8	2.188	.4571
6.9	2.213	.4519
7.0	2.239	.4467
7.1	2.265	.4416
7.2	2.291	.4365
7.3	2.317	.4315
7.4	2.344	.4266
7.5	2.371	.4217
7.6	2.399	.4169
7.7	2.427	.4121
7.8	2.455	.4074
7.9	2.483	.4027
8.0	2.512	.3981
8.1	2.541	.3936
8.2	2.570	.3890
8.3	2.600	.3846
8.4	2.630	.3802
8.5	2.661	.3758
8.6	2.692	.3715
8.7	2.723	.3673
8.8	2.754	.3631
8.9	2.786	.3589
9.0	2.818	.3548
9.1	2.851	.3508
9.2	2.884	.3467
9.3	2.917	.3428
9.4	2.951	.3388
9.5	2.985	.3350
9.6	3.020	.3311
9.7	3.055	.3273
9.8	3.090	.3236
9.9	3.126	.3199
10.0	3.162	.3162
10.1	3.199	.3126
10.2	3.236	.3090
10.3	3.273	.3055
10.4	3.311	.3020
10.5	3.350	.2985
10.6	3.388	.2951
10.7	3.428	.2917
10.8	3.467	.2884
10.9	3.508	.2851
11.0	3.548	.2818
11.1	3.589	.2786
11.2	3.631	.2754
11.3	3.673	.2723
11.4	3.715	.2692
11.5	3.758	.2661
11.6	3.802	.2630
11.7	3.846	.2600
11.8	3.890	.2570
11.9	3.936	.2541
12.0	3.981	.2512
12.1	4.027	.2483
12.2	4.074	.2455
12.3	4.121	.2427
12.4	4.169	.2399
12.5	4.217	.2371
12.6	4.266	.2344
12.7	4.315	.2317
12.8	4.365	.2291
12.9	4.416	.2265
13.0	4.467	.2239
13.1	4.519	.2213
13.2	4.571	.2188

25 Hands-on Electronics FactCard

CMOS IC's: 4009 4010





MAXIMUM RATINGS *(Absolute-Maximum Values)*

DC SUPPLY-VOLTAGE RANGE, (V_{DD}, V_{CC})
(Voltages referenced to V_{SS} Terminal) . . . . −0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS . . . . −0.5 to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT . . . . ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = −40 to +60°C (PACKAGE TYPE E) . . . . 500 mW
For T_A = +60 to +85°C (PACKAGE TYPE E) Derate Linearly at 12 mW/°C to 200 mW
For T_A = −55 to +100°C (PACKAGE TYPES D,F) . . . . 500 mW
For T_A = +100 to +125°C (PACKAGE TYPES D,F) Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100 mW
OPERATING-TEMPERATURE RANGE (T_A):
PACKAGE TYPES D,F,H . . . . −55 to +125°C
PACKAGE TYPE E . . . . −40 to +85°C
STORAGE TEMPERATURE RANGE (T_{stg}) . . . . −65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10s max . . . . . . +265°C

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range), V_{DD}	3	18	V
V_{CC}	3	V_{DD}	
Input Voltage Range (V_I)	V_{CC}	V_{DD}	V

4009: Static Electrical
4010: Characteristics

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.02	μA
	—	0,10	10	0.02	
	—	0,15	15	0.02	
	—	0,20	20	0.04	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	4	mA
	0.5	0,10	10	10	
	1.5	0,15	15	36	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−0.4	
	2.5	0,5	5	−1.6	
	9.5	0,10	10	−0.9	
	13.5	0,15	15	−3	
Output Voltage: Low Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Input Low Voltage, V_{IL} Max. 4009	4.5	—	5	1	V
	9	—	10	2	
	13.5	—	15	2.5	
Input Low Voltage, V_{IH} Max. 4010	0.5	—	5	1.5	
	1	—	10	3	
	1.5	—	15	4	
Input High Voltage: V_{IH} Min. 4009	0.5	—	5	4	
	1	—	10	8	
	1.5	—	15	12.5	
Input High Voltage: V_{IH} Min. 4010	4.5	—	5	3.5	
	9	—	10	7	
	13.5	—	15	11	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	μA

24 Hands-on Electronics FactCard

CMOS IC's: 4008

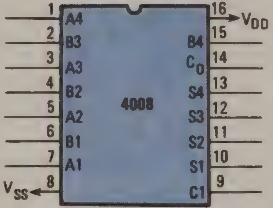
STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current I_{DD} Max.	—	0,5	5	0.04	µA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
	—	0,20	20	0.08	
Output Low (Sink) Current, I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current, I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS			LIMIT at 25°C (TYP)	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage: Low Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	1.5	V
	1,9	—	10	3	
	1.5,13.5	—	15	4	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	3.7	
	1,9	—EP	10	7	
	1.5,13.5	—	15	11	

24 Hands-on Electronics FactCard

CMOS IC's: 4008



MAXIMUM RATINGS *(Absolute-Maximum Values)*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})	
(Voltages referenced to V_{SS} Terminal)	−0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS	−0.5 to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT	+10 mA
POWER DISSIPATION PER PACKAGE (P_D):	
For T_A = −40 to +60°C (PACKAGE TYPE E)	500 mW
For T_A = +60 to +85°C (PACKAGE TYPE E) Derate Linearly at 12 mW/°C to 200 mW	
For T_A = −55 to +100°C (PACKAGE TYPES D,F)	500 mW
For T_A = +100 to +125°C (PACKAGE TYPES D,F) Derate Linearly at 12 mW/°C to 200 mW	
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100 mW
OPERATING-TEMPERATURE RANGE (T_A):	
PACKAGE TYPES D,F,H	−55 to +125°C
PACKAGE TYPE E	−40 to +85°C
STORAGE TEMPERATURE RANGE (T_{stg})	−65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):	
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10s max	+265°C

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range)	3	18	V

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Hands-on Electronics FactCard

Voltage Regulator Selection Guide

Three Terminal Regulators

Type	Polarity	Case	V_{OUT} min	V_{OUT} typ	V_{OUT} max	I_{OUT} (nom)	Dropout Voltage
78L05	positive	TO-92	4.8	5	5.2	100mA	1.7
78L62	positive	TO-92	5.95	6.2	6.45	100mA	1.7
78L09	positive	TO-92	8.64	9	9.36	100mA	1.7
78L12	positive	TO-92	11.5	12	12.5	100mA	1.7
78L15	positive	TO-92	14.4	15	15.6	100mA	1.7
7805	positive	TO-220	4.8	5	5.2	1A	2
7806	positive	TO-220	5.75	6	6.25	1A	2
7809	positive	TO-220	8.64	9	9.36	1A	2
7812	positive	TO-220	11.5	12	12.5	1A	2
7815	positive	TO-220	14.4	15	15.6	1A	2
7824	positive	TO-220	23	24	25	1A	2
7905	negative	TO-220	−4.8	−6	−5.2	1A	1.1
7912	negative	TO-220	−11.5	−12	−12.5	1A	1.1
7915	negative	TO-220	−14.4	−15	−15.6	1A	1.1
LM317K	positive	TO-3		adj. 1.2 to 37		1.5A(min)	
LM317T	positive	TO-220		adj. 1.2 to 37		1.5A(min)	
LM350K	positive	TO-3		adj. 1.2 to 33		3A	
LM350T	positive	TO-220		adj. 1.2 to 33		3A	
78H06	positive	TO-3	4.85	5	5.25	5A	2.5

23 Hands-on Electronics FactCard

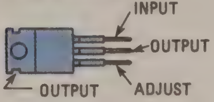
Zener Diode Selection Guide

Type Number	Power Dissipation Rating at 50°C (Amps)	V_Z (Volts)	$I_Z(T)$ (mA)	Type Number	Power Dissipation Rating at 50°C (Amps)	V_Z (Volts)	$I_Z(T)$ (mA)	Type Number	Power Dissipation Rating at 50°C (Amps)	V_Z (Volts)	$I_Z(T)$ (mA)
1N746	.4	3.3	20	1N963	.4	12	11.5	1N4735	1	6.2	41
1N747	.4	3.6	20	1N964	.4	13	10.5	1N4736	1	6.8	37
1N748	.4	3.9	20	1N965	.4	15	9.5	1N4737	1	7.5	34
1N750	.4	4.7	20	1N966	.4	16	8.5	1N4738	1	8.2	31
1N751	.4	5.1	20	1N967	.4	18	7.8	1N4739	1	9.1	28
1N752	.4	5.6	20	1N968	.4	20	7	1N4740	1	10	25
1N753	.4	6.2	20	1N969	.4	22	6.2	1N4741	1	11	23
1N754	.4	6.8	18.5	1N970	.4	24	5.6	1N4742	1	12	21
1N755	.4	7.5	16.5	1N971	.4	27	5.3	1N4743	1	13	19
1N756	.4	8.2	15	1N972	.4	30	5.3	1N4744	1	15	17
1N757	.4	9.1	14	1N973	.4	33	5.2	1N4745	1	16	15.5
1N758	.4	10	14	1N4112	.4	18	7.8	1N4746	1	18	14
1N759	.4	12	12	1N4728	1	3.3	76	1N4747	1	20	12.5
1N957	.4	6.8	18.5	1N4729	1	3.6	69	1N4748	1	22	11.5
1N958	.4	7.5	16.5	1N4730	1	3.9	64	1N4749	1	24	10.5
1N959	.4	8.2	15	1N4732	1	4.7	53	1N4750	1	27	9.5
1N960	.4	9.1	14	1N4733	1	5.1	49	1N4751	1	30	8.5
1N961	.4	10	14	1N4734	1	5.6	45	1N4752	1	33	7.5
1N962	.4	11	12.5								

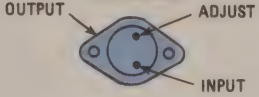
22 Hands-on Electronics **FactCard**

Regulator Packages

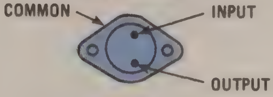
LM317T/LM350T
(POSITIVE REGULATOR)
TO-220 PACKAGE



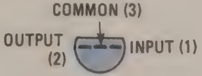
LM317K/LM350K
(POSITIVE REGULATOR)
TO-3 PACKAGE



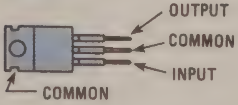
78H05
(POSITIVE REGULATOR)
TO-3 PACKAGE



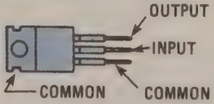
78Lxx
(POSITIVE REGULATOR)
TO-92 PACKAGE



78xx
(POSITIVE REGULATOR)
TO-220 PACKAGE

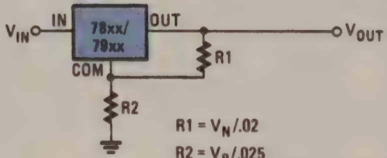


79xx
(NEGATIVE REGULATOR)
TO-220 PACKAGE



22 Hands-on Electronics FactCard — Using Voltage Regulators

BOOSTING VOLTAGE



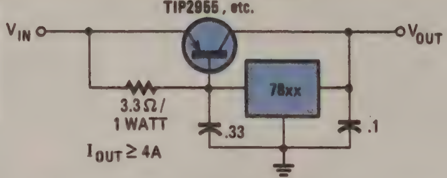
$R1 = V_N/.02$

$R2 = V_B/.025$

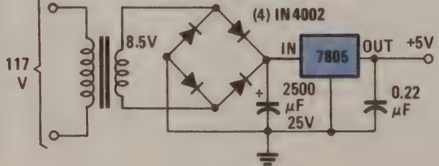
WHERE: V_N = REGULATOR'S NOMINAL VOLTAGE

V_B = BOOSTED VOLTAGE DESIRED

BOOSTING CURRENT



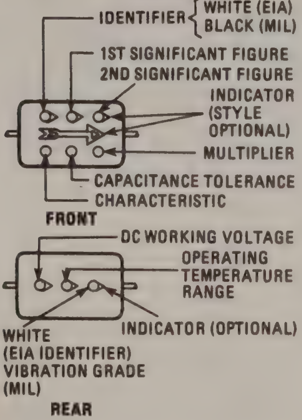
TYPICAL POWER-SUPPLY CIRCUIT



21 Hands-on Electronics FactCard

Capacitor Codes

COLOR CODE FOR MOLDED MICA CAPACITORS



CAPACITOR CHARACTERISTIC CODE

Color	Temperature Coefficient (ppm/°C)	Capacitance Drift
Black	±1000	±5% +1 pF
Brown	±500	±3% +1 pF
Red	±200	±0.5%
Orange	±100	±0.3%
Yellow	−20 to +100	±0.1% +0.1 pF
Green	0 to +70	±0.05% +0.1 pF

EIA TEMPERATURE CHARACTERISTIC CODE FOR DISC CERAMIC CAPACITORS

Minimum Temperature	
X	−55°C
Y	−30°C
Z	+10°C

Maximum Temperature	
2	+45°C
4	+65°C
5	+85°C
6	+105°C
7	+125°C

Max. Cap. Change Over Temp. Range	
A	±1.0%
B	±1.5%
C	±2.2%
D	±3.3%
E	±4.7%
F	±7.5%
P	±10%
R	±15%
S	±22%
T	−33%, +22%
U	−56%, +22%
V	−82%, +22%

21 Hands-on Electronics **FactCard**

Capacitor Codes

Color Code for Molded Mica Capacitors

	Capacitance					
Color	1st and 2nd Significant Figures	Multiplier	Capacitance Tolerance	DC Working Voltage	Operating Temperature Range	Vibration Grade (MIL)
Black	0	1	±20% (EIA)		−55° to +70°C (MIL)	10-55 Hz
Brown	1	10	±1%	100 (EIA)		
Red	2	100	±2%		−55° to + 85°C	
Orange	3	1000		300		
Yellow	4	10,000 (EIA)			−55° to +125°C	10-2000 Hz
Green	5		±5%	500		
Blue	6				−55° to +150°C (MIL)	
Purple (violet)	7					
Gray	8					
White	9					
Gold		0.1	±½% (EIA)	1000 (EIA)		
Silver		0.01 (EIA)	±10%			

20 Hands-on Electronics FactCard (Dual Complementary Pair Plus Inverter)

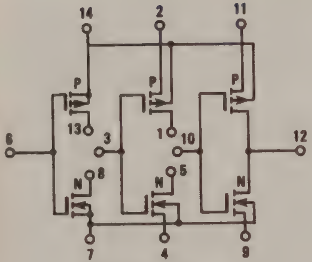
STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC (25°C)	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.01	µA
	—	0,10	10	0.01	
	—	0,15	15	0.01	
	—	0,20	20	0.02	
Output Low (Sink)Current I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.		0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC (25°C)	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage Low-Level V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	1.5	V
	1,9	—	10	3	
	1.5,13.5	—	15	4	
Input High Voltage V_{IH} Min.	0.5,4.5	—	5	3.5	
	1,9	—	10	7	
	1.5,13.5	—	15	11	

20 **Hands-on Electronics** **FactCard**

4007: (Dual Complementary Pair Plus Inverter)



TERMINAL NO. 14 - V_{DD}
TERMINAL NO. 7 - V_{SS}

FUNCTIONAL DIAGRAM

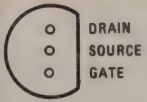
MAXIMUM RATINGS *(Absolute-Maximum Values)*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal) .... −0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS.............. −0.5 TO V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT .... ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = −40 to +60°C ....500 mW
For T_A = +60 to +85°C.......... Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE TEMPERATURE RANGE...........100 mW
OPERATING TEMPERATURE RANGE (T_A): .... −40 to +85°C
STORAGE TEMPERATURE RANGE (T_{STG})............... −65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 s max. +265°C

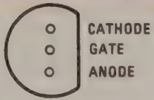
RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T_A = Full Package Temperature Range)	3	18	V

19 Hands-on Electronics FactCard — Transistor Pinouts



TO-92c



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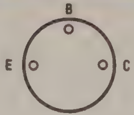
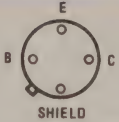
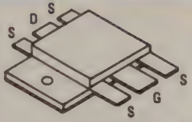


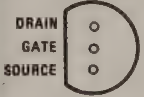
TO-106



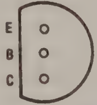
SO-12a



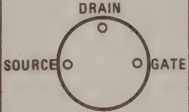
C220



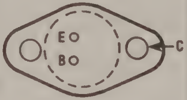
TO-92d



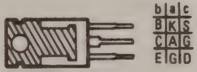
TO-92h



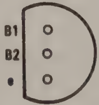
TO-106f



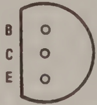
SO-55



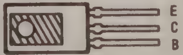
P1
(ALSO PLASTIC TO-66)



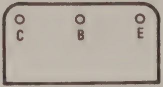
TO-92e



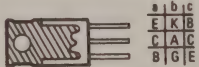
TO-98



TO-126

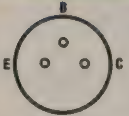


E-LINE

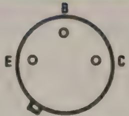


P3
(ALSO PLASTIC TO-3)

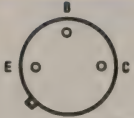
19 Hands-on Electronics FactCard Transistor Pinouts



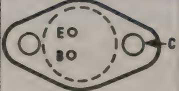
TO-1a



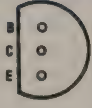
TO-5



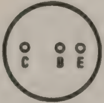
TO-18



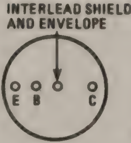
TO-66



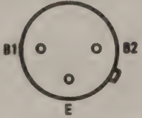
TO-92



TO-1b

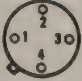


TO-7



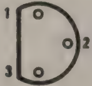
TO-18a

SHIELD LEAD CONNECTED TO CASE



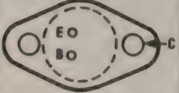
	-	g
1	e	d
2	b	s
3	c	g
4	sh	sh

TO-72

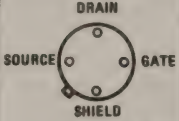


	a	k
1	E	B
2	B	E
3	C	C

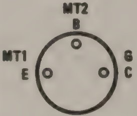
TO-92a



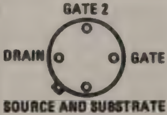
TO-3



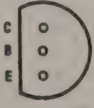
TO-12



TO-39



TO-72f



TO-92b

18 Hands-on Electronics FactCard

4006 (18-Stage Static Shift Register)

STATIC ELECTRICAL CHARACTERISTICS ($T_A = 25°C$)

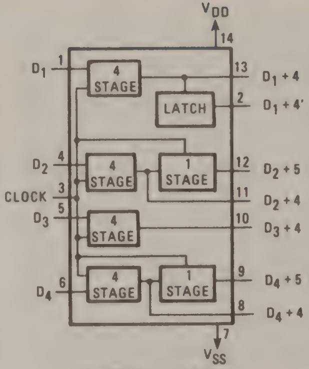
CHARACTERISTIC	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.04	µA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
	—	0,20	20	0.08	
Output Low (Sink)Current I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage Low-Level V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	—	V
	1,9	—	10	—	
	1.5,13.5	—	15	—	
Input High Voltage V_{IH} Min.	0.5,4.5	—	5	—	
	1,9	—	10	—	
	1.5,13.5	—	15	—	

18 Hands-on Electronics

FactCard

4006 (18-Stage Static Shift Register)



FUNCTIONAL DIAGRAM

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	V_{DD} (V)	LIMITS Min.	LIMITS Max.	UNITS
Supply-Voltage Range (For T_A = Full Package Temperature Range)	—	3	18	V
Clock Pulse Width, t_W	5 10 15	180 80 50	— — —	ns
Data Setup Time, t_S	5 10 15	100 50 40	— — —	ns
Data Hold Time, t_H	5 10 15	60 40 30	— — —	ns
Clock Rise of Fall Time: t_r, t_f	5,10, 15	—	15	µs
Clock Input Frequency, f_{CL}	5 10 15	— — —	2.5 5 7	MHz

17 Hands-on Electronics **FactCard**

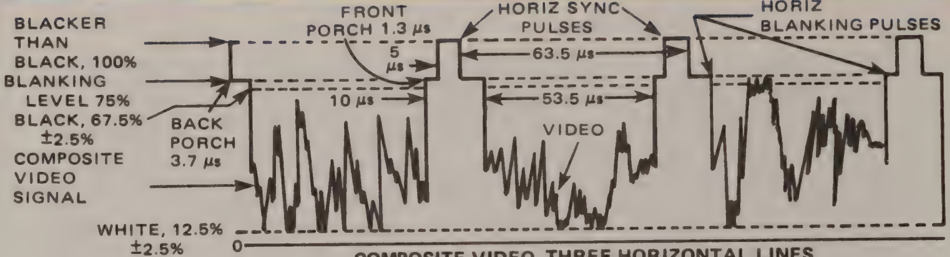
NTSC Video

VIDEO SIGNAL COMPONENTS

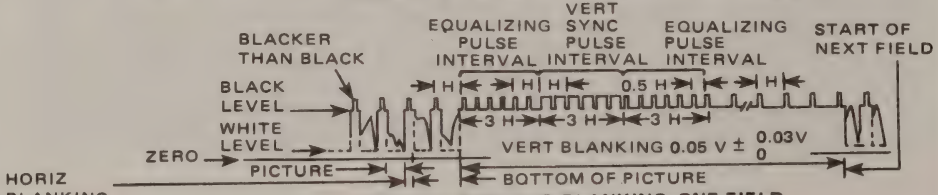
Signal	Frequency	Purpose
1. Black & white video signal	0—4.2 MHz	Represents the black & white picture information
2. Color signal	3.58 MHz + 0.5 MHz − 1.5 MHz	Represents the color picture information
3. Horizontal blanking pulses	15,750-Hz B&W, 15,734-Hz color	Turns off picture tube during horizontal retrace
4. Vertical blanking pulses	60-Hz B&W, 59.94-Hz color	Turns off picture tube during vertical retrace
5. Horizontal sync pulses	15,750-Hz B&W, 15,734-Hz color	Forces the receiver's horizontal oscillator to be in step with the transmitter's
6. Vertical sync pulses	60-Hz B&W, 59.94-Hz color	Forces the receiver's vertical oscillator to be in step with the transmitter's
7. Equalizing pulses	Twice the horizontal frequency	Prevents the loss of interlace scanning
8. Color burst	3.58 MHz	Synchronizes the receiver color circuits with the transmitter's
9. VITS	Various frequencies	Studio test signals

17 **Hands-on Electronics FactCard**

NTSC Video



COMPOSITE VIDEO, THREE HORIZONTAL LINES

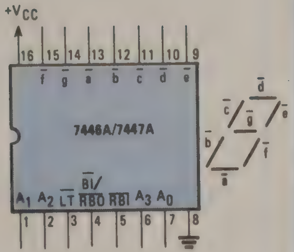


VERTICAL SYNC AND BLANKING, ONE FIELD

16 Hands-on Electronics **FactCard**

7446A/7447A

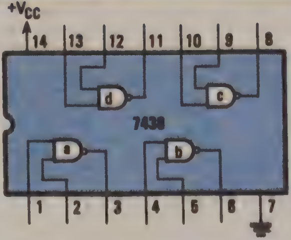
(BCD-to-Decimal Decoder Driver)

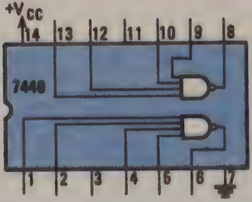


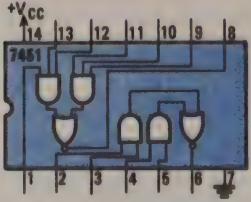
DECIMAL OR FUNCTION	INPUTS							OUTPUTS						
	$\overline{LT}$	$\overline{RBI}$	A_3	A_2	A_1	A_0	BI/RBO	$\bar{a}$	$\bar{b}$	$\bar{c}$	$\bar{d}$	$\bar{e}$	$\bar{f}$	$\bar{g}$
0	H	H	L	L	L	L	H	L	L	L	L	L	L	H
1	H	X	L	L	L	H	H	H	L	L	H	H	H	H
2	H	X	L	L	H	L	H	L	L	H	L	L	H	L
3	H	X	L	L	H	H	H	L	L	L	L	H	H	L
4	H	X	L	H	L	L	H	H	L	L	H	H	L	L
5	H	X	L	H	L	H	H	L	H	L	L	H	L	L
6	H	X	L	H	H	L	H	H	H	L	L	L	L	L
7	H	X	L	H	H	H	H	L	L	L	H	H	H	H
8	H	X	H	L	L	L	H	L	L	L	L	L	L	L
9	H	X	H	L	L	H	H	L	L	L	H	H	L	L
10	H	X	H	L	H	L	H	H	H	H	L	L	H	L
11	H	X	H	L	H	H	H	H	H	L	L	H	H	L
12	H	X	H	H	L	L	H	H	L	H	H	H	L	L
13	H	X	H	H	L	H	H	L	H	H	L	H	L	L
14	H	X	H	H	H	L	H	H	H	H	L	L	L	L
15	H	X	H	H	H	H	H	H	H	H	H	H	H	H
$\overline{BI}$	X	X	X	X	X	X	L	H	H	H	H	H	H	H
$\overline{RBI}$	H	L	L	L	L	L	L	H	H	H	H	H	H	H
$\overline{LT}$	L	X	X	X	X	X	H	L	L	L	L	L	L	L

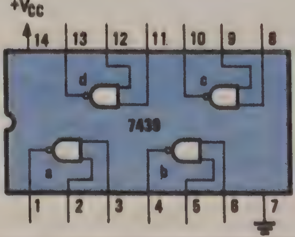
16 Hands-on Electronics FactCard

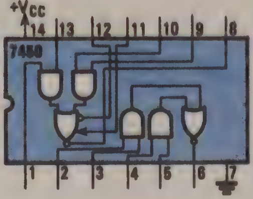
TTL GATES: 7438, 7439, 7440, 7450, 7451, 7452

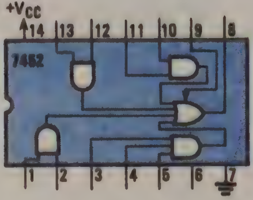












15

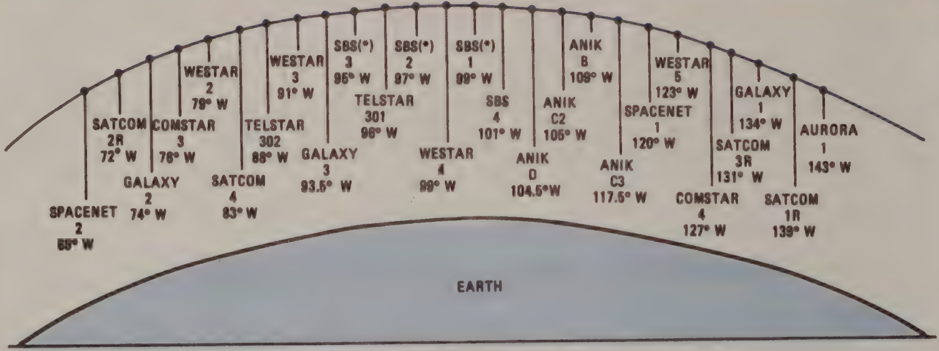
Hands-on Electronics FactCard

TV Frequencies

Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			UHF Band			
40	626-632	629	627.25	630.83	631.75	673
41	632-638	635	633.25	636.83	637.75	679
42	638-644	641	639.25	642.83	643.75	685
43	644-650	647	645.25	648.83	649.75	691
44	650-656	653	651.25	654.83	655.75	697
45	656-662	659	657.25	660.83	661.75	703
46	662-668	665	663.25	666.83	667.75	709
47	668-674	671	669.25	672.83	673.75	715
48	674-680	677	675.25	678.83	679.75	721
49	680-686	683	681.25	684.83	685.75	727
50	686-692	689	687.25	690.83	691.75	733
51	692-698	695	693.25	696.83	697.75	739
52	698-704	701	699.25	702.83	703.75	745
53	704-710	707	705.25	708.83	709.75	751
54	710-716	713	711.25	714.83	715.75	757
55	716-722	719	717.25	720.83	721.75	763
56	722-728	725	723.25	726.83	727.75	769
57	728-734	731	729.25	732.83	733.75	775
58	734-740	737	735.25	738.83	739.75	781
59	740-746	743	741.25	774.83	745.75	787
60	746-752	749	747.25	750.83	751.75	793
61	752-758	755	753.25	756.83	757.75	799
62	758-764	761	759.25	762.83	763.75	805
63	764-770	767	765.25	768.83	769.75	811

Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			UHF Band			
64	770-776	773	771.25	774.83	775.75	817
65	776-782	779	777.25	780.83	781.75	823
66	782-788	785	783.25	786.83	787.75	829
67	788-794	791	789.25	792.83	793.75	835
68	794-800	797	795.25	798.83	799.75	841
69	800-806	803	801.25	804.83	805.75	847
70	806-812	809	807.25	810.83	811.75	853
71	812-818	815	813.25	816.83	817.75	859
72	818-824	821	819.25	822.83	823.75	865
73	824-830	827	825.25	828.83	829.75	871
74	830-836	833	831.25	834.83	835.75	877
75	836-842	839	837.25	840.83	841.75	883
76	842-848	845	843.25	846.83	847.75	889
77	848-854	851	849.25	852.83	853.75	895
78	854-860	857	855.25	858.83	859.75	901
79	860-866	863	861.25	864.83	865.75	907
80	866-872	869	867.25	870.83	871.75	913
81	872-878	875	873.25	876.83	877.75	919
82	878-884	881	879.25	882.83	883.75	925
83	884-890	887	885.25	888.83	889.75	931

15 Hands-on Electronics FactCard — Satellite TV



*12 GHz BAND
SATELLITE

14 Hands-on Electronics **FactCard**

TV Frequencies

Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			Hyper Band			
AA-(37)	300-306	303	301.25	304.83	305.75	347
BB-(38)	306-312	309	307.25	310.83	311.75	353
CC-(39)	312-318	315	313.25	316.83	317.75	359
DD-(40)	318-324	321	319.25	322.83	323.75	365
EE-(41)	324-330	327	325.25	328.83	329.75	371
FF-(42)	330-336	333	331.25	334.83	335.75	377
GG-(43)	336-342	339	337.25	340.83	341.75	383
HH-(44)	342-348	345	343.25	346.83	347.75	389
II-(45)	348-354	351	349.25	352.83	353.75	395
JJ-(46)	354-360	357	355.25	358.83	359.75	401
KK-(47)	360-366	363	361.25	364.83	365.75	407
LL-(48)	366-372	369	367.25	370.83	371.75	413
MM-(49)	372-378	375	373.25	376.83	377.75	419
NN-(50)	378-384	381	379.25	382.83	383.75	425
OO-(51)	384-390	387	385.25	388.83	389.75	431
PP-(52)	390-396	393	391.25	394.83	395.75	437
QQ-(53)	396-402	399	397.25	400.83	401.75	443
RR-(54)	402-408	405	403.25	406.83	407.75	449
			UHF Band			
14	470-476	473	471.25	474.83	475.75	517
15	476-482	479	477.25	480.83	481.75	523
16	482-488	485	483.25	486.83	487.75	529

Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			VHF High Band			
17	488-494	491	489.25	492.83	493.75	535
18	494-500	497	495.25	498.83	499.75	541
19	500-506	503	501.25	504.83	505.75	547
20	506-512	509	507.25	510.83	511.75	553
21	512-518	515	513.25	516.83	517.75	559
22	518-524	521	519.25	522.83	523.75	565
23	524-530	527	525.25	528.83	529.75	571
24	530-536	533	531.25	534.83	535.75	577
25	536-542	539	537.25	540.83	541.75	583
26	542-548	545	543.25	546.83	547.75	589
27	548-554	551	549.25	552.83	553.75	595
28	554-560	557	555.25	558.83	559.75	601
29	560-566	563	561.25	564.83	565.75	607
30	566-572	569	567.25	570.83	571.75	613
31	572-578	575	573.25	576.83	577.75	619
32	578-584	581	579.25	582.83	583.75	625
33	584-590	587	585.25	588.83	589.75	631
34	590-596	593	591.25	594.83	595.75	637
35	596-602	599	597.25	600.83	601.75	643
36	602-608	605	603.25	606.82	607.75	649
37	608-614	611	609.25	612.83	613.75	655
38	614-620	617	615.25	618.83	619.75	661
39	620-626	623	621.25	624.83	625.75	667

14 **Hands-on Electronics** FactCard

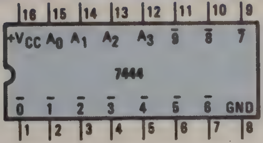
TV Frequencies

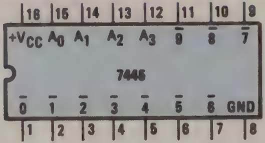
Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			VHF Low Band			
2	54- 60	57	55.25	58.83	59.75	101
3	60- 66	63	61.25	64.83	65.75	107
4	66- 72	69	67.25	70.83	71.75	113
5	76- 82	79	77.25	80.83	81.75	123
6	82- 88	85	83.25	86.83	87.75	129
			Mid Band			
A-2(00)	108-114	111	109.25	112.83	113.75	155
A-1(01)	114-120	117	115.25	118.83	119.75	161
A- (14)	120-126	123	121.25	124.83	125.75	167
B- (15)	126-132	129	127.25	130.83	131.75	173
C- (16)	132-138	135	133.25	136.83	137.75	179
D- (17)	138-144	141	139.25	142.83	143.75	185
E- (18)	144-150	147	145.25	148.83	149.75	191
F- (19)	150-156	153	151.25	154.83	155.75	197
G- (20)	156-162	159	157.25	160.83	161.75	203
H- (21)	162-168	165	163.25	166.83	167.75	209
I- (22)	168-174	171	169.25	172.83	173.75	215
			VHF High Band			
7	174-180	177	175.25	178.83	179.75	221
8	180-186	183	181.25	184.83	185.75	227
9	186-192	189	187.25	190.83	191.75	233

Channel	Band	Center Freq.	Video Carrier	Color Carrier	Sound Carrier	Osc. Freq.
			VHF High Band			
10	192-198	195	193.25	196.83	197.75	239
11	198-204	201	199.25	202.83	203.75	245
12	204-210	207	205.25	208.83	209.75	251
13	210-216	213	211.25	214.83	215.75	257
			Super Band			
J-(23)	216-222	219	217.25	220.83	221.75	263
K-(24)	222-228	225	223.25	226.83	227.75	269
L-(25)	228-234	231	229.25	232.83	233.75	275
M-(26)	234-240	237	235.25	238.83	239.75	281
N-(27)	240-246	243	241.25	244.83	245.75	287
O-(28)	246-252	249	247.25	250.83	251.75	293
P-(29)	252-258	255	253.25	256.83	257.75	299
Q-(30)	258-264	261	259.25	262.83	263.75	305
R-(31)	264-270	267	265.25	268.83	269.75	311
S-(32)	270-276	273	271.25	274.83	275.75	317
T-(33)	276-282	279	277.25	280.83	281.75	323
U-(34)	282-288	285	283.25	286.83	287.75	329
V-(35)	288-294	291	289.25	292.83	293.75	335
W-(36)	294-300	297	295.25	298.83	299.75	341

13 Hands-on Electronics FactCard

7444 (Excess-3-Gray-to-Decimal Decoder), 7445 (BCD-to-Decimal Decoder/Driver)





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L	H	L	H	H	H	H	L	H	H	H	H	H	H
L	H	L	L	H	H	H	H	L	H	H	H	H	H
H	H	L	L	H	H	H	H	H	L	H	H	H	H
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H	L	H	L	H	H	H	H	H	H	H	H	H	L
H	L	H	H	H	H	H	H	H	H	H	H	H	H
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H	L	L	L	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H

A_3	A_2	A_1	A_0	$\overline{0}$	$\overline{1}$	$\overline{2}$	$\overline{3}$	$\overline{4}$	$\overline{5}$	$\overline{6}$	$\overline{7}$	$\overline{8}$	$\overline{9}$
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L	L	H	L	H	H	L	H	H	H	H	H	H	H
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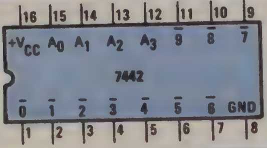
H	L	H	L	H	H	H	H	H	H	H	H	H	H
H	L	H	H	H	H	H	H	H	H	H	H	H	H
H	H	L	L	H	H	H	H	H	H	H	H	H	H
H	H	L	H	H	H	H	H	H	H	H	H	H	H
H	H	H	L	H	H	H	H	H	H	H	H	H	H
H	H	H	H	H	H	H	H	H	H	H	H	H	H

13 Hands-on Electronics **FactCard**

7442 (BCD-to Decimal Decoder), 7443 (Excess-3-to-Decimal Decoder)



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L	L	H	L	H	H	L	H	H	H	H	H	H	H
L	L	H	H	H	H	H	L	H	H	H	H	H	H
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H	L	H	L	H	H	H	H	H	H	H	H	H	H
H	L	H	H	H	H	H	H	H	H	H	H	H	H
H	H	L	L	H	H	H	H	H	H	H	H	H	H
H	H	L	H	H	H	H	H	H	H	H	H	H	H
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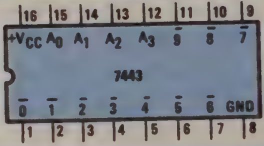

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L	H	L	H	H	H	L	H	H	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H	H	H
L	H	H	H	H	H	H	H	L	H	H	H	H	H
H	L	L	L	L	H	H	H	H	L	H	H	H	H
H	L	L	H	H	H	H	H	H	H	L	H	H	H
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H	L	H	H	H	H	H	H	H	H	H	H	L	H
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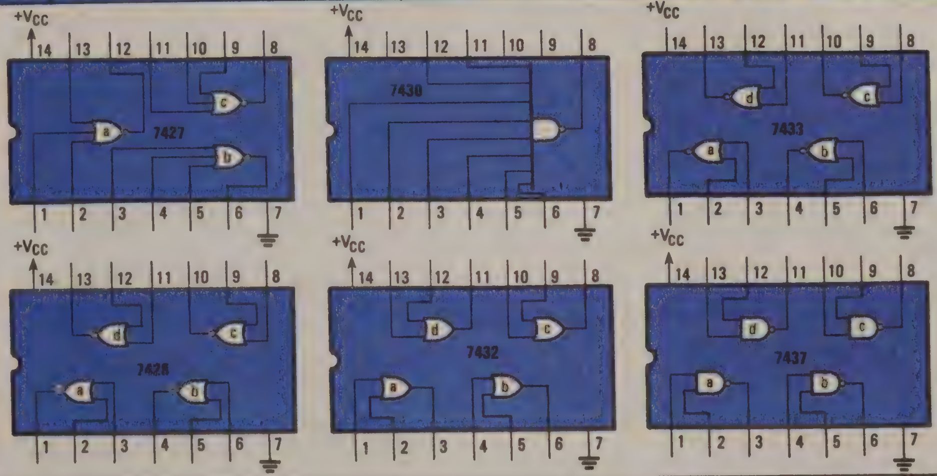
H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H

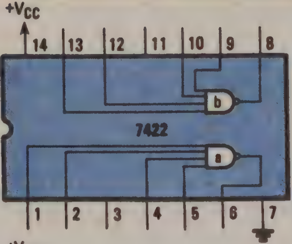
12 Hands-on Electronics **FactCard**

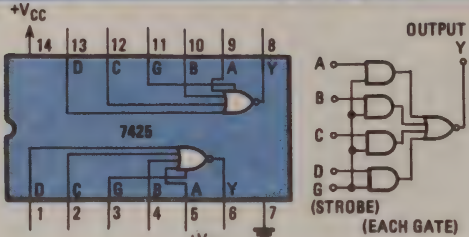
TTL Gates: 7427, 7428, 7430 7432, 7433, 7437

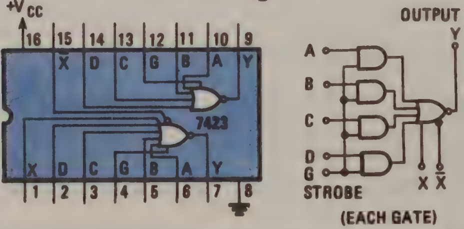


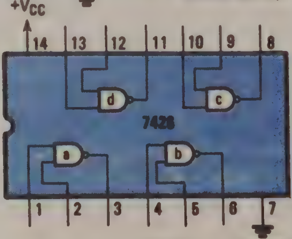
12 **Hands-on Electronics FactCard**

TTL Gates: 7422, 7423 7425, 7426









11 Hands-on Electronics FactCard

Bipolar Transistors

TRANSISTOR SELECTION GUIDE

Transistor Number	Cross-Ref. to ECG	V_{CEO} (Min)	V_{CE} (Sat.) Max.	h_{FE} (Min-Max)	Type
MPSA05	123AP	60	.25	50-150	NPN
MPSA06	128	80	.25	50-150	NPN
TIP29A	152	60	.7	15-150	NPN
TIP30A	153	−60	−.7	15-150	PNP
TIP31A	152	60	1.2	10-50	NPN
TIP32A	153	−60	−1.20	10-50	PNP
TIP41A	331	60	2.0	15-150	NPN
TIP42A	332	−60	−2.0	15-150	PNP
TIS97	107	40	1	250-700	NPN
TIS98	107	60	1	100-300	NPN
2N918	108	15	.4	20	NPN
2N2219A	123AP	40	.3	100-200	NPN
2N2221A	123AP	40	.3	40-120	NPN
PN2222	123AP	40	.3	100-300	NPN
2N2222A	123AP	40	.3	100-300	NPN
MPSA05	123AP	60	.25	50-150	NPN
2N5771	194	4.5	.18	50-120	PNP
MPS2369	107	15	.25	20-120	NPN
2N2484	123AP	60	.35	100-500	NPN
2N2906A	159	60	.4	40-120	PNP
PN2907	159	60	.4	100-300	PNP
PN2907A	159	60	.4	100-300	PNP
2N2925	123AP	25	.3	150-300	NPN
MJE2955T	183	60	1.1	20-70	PNP
2N3053	128	40	1.4	25-150	NPN
2N3398	123AP	25	—	55-800	NPN
2N3567	128	40	.25	40-300	NPN
PN3568	128	60	.25	40-300	NPN
PN3569	128	40	.25	100-300	NPN
2N3638A	159	25	.25	20-100	PNP
MPS3640	159	12	.2	30-120	PNP

11 Hands-on Electronics FactCard

Bipolar Transistors

TRANSISTOR SELECTION GUIDE

Transistor Number	Cross-Ref. to ECG	V_{CEO} (Min)	V_{CE} (Sat.) Max.	h_{FE} (Min-Max)	Type
2N3702	159	40	.25	60-300	PNP
2N3704	123AP	30	.6	100-300	NPN
2N3705	123AP	30	.8	50-150	NPN
2N3706	123AP	40	1	30-600	NPN
2N3711	123AP	30	1	180-660	NPN
2N3724	235	30	.25	60-150	PNP
2N3725	128	50	.25	60-150	NPN
2N3903	123AP	60	.3	50-150	NPN
2N3904	123AP	40	.3	100-300	NPN
2N3905	159	40	.25	50-150	PNP
2N3906	159	40	.25	100-150	PNP
2N4013	123AP	30	.25	30-150	NPN
2N4123	123AP	30	.3	50-150	NPN
2N4124	123AP	25	.3	120-360	NPN
2N4125	159	30	.4	50-100	PNP
2N4249	159	60	.25	100-300	PNP
2N4400	123AP	40	.4	50-150	NPN
2N4401	123AP	40	.4	100-300	NPN
2N4402	159AP	40	.4	50-150	PNP
2N4403	159AP	40	.4	50-150	PNP
2N4409	194	50	.2	60-400	NPN
2N5086	159	50	.3	150-500	PNP
2N5087	159	50	.3	250-800	PNP
2N5088	123AP	30	.5	300-900	NPN
2N5089	123AP	35	.5	400-1200	NPN
2N5129	128	12	.25	20-250	NPN
PN5134	123AP	10	.25	20-150	NPN
PN5138	159	30	.3	50-800	PNP
2N5139	193	20	.5	40-350	PNP
2N5210	123	50	.7	200-600	NPN

10 Hands-on Electronics **FactCard**

Wire Table

COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
20	32.0	1022	29.4	25.8	23.8	10.15	1.46	.812
21	28.5	810	33.1	—	26.0	12.8	1.16	.723
22	25.3	642	37.0	31.3	30.0	16.14	.918	.644
23	22.6	510	41.3	—	37.6	20.36	.728	.573
24	20.1	404	46.3	37.6	35.6	25.67	.577	.511
25	17.9	320	51.7	—	38.6	32.37	.458	.455
26	15.9	254	58.0	46.1	41.8	40.81	.363	.405
27	14.2	202	64.9	—	45.0	51.47	.288	.361
28	12.6	160	72.7	54.6	48.5	64.9	.228	.321
29	11.3	127	81.6	—	51.8	81.83	.181	.286
30	10.0	101	90.5	64.1	55.5	103.2	.144	.255
31	8.9	80	101	—	59.2	130.1	.114	.227
32	8.0	63	113	74.1	61.6	164.1	.090	.202
33	7.1	50	127	—	66.3	206.9	.072	.180
34	6.3	40	143	86.2	70.0	260.9	.057	.160
35	5.6	32	158	—	73.5	329.0	.045	.143
36	5.0	25	175	103.1	77.0	414.8	.036	.127
37	4.5	20	198	—	80.3	523.1	.028	.113
38	4.0	16	224	116.3	83.6	659.6	.022	.101
39	3.5	12	248	—	86.6	831.8	.018	.090

10 Hands-on Electronics FactCard

Wire Table

COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear Inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
1	289.3	83690	—	—	—	.1239	119.6	7.348
2	257.6	66370	—	—	—	.1563	94.8	6.544
3	229.4	52640	—	—	—	.1970	75.2	5.827
4	204.3	41740	—	—	—	.2485	59.6	5.189
5	181.9	33100	—	—	—	.3133	47.3	4.621
6	162.0	26250	—	—	—	.3951	37.5	4.115
7	144.3	20820	—	—	—	.4982	29.7	3.665
8	128.5	16510	7.6	—	7.1	.6282	23.6	3.264
9	114.4	13090	8.6	—	7.8	.7921	18.7	2.906
10	101.9	10380	9.6	9.1	8.9	.9989	14.8	2.588
11	90.7	8234	10.7	—	9.8	1.26	11.8	2.305
12	80.8	6530	12.0	11.3	10.9	1.588	9.33	2.053
13	72.0	5178	13.5	—	12.8	2.003	7.40	1.828
14	64.1	4107	15.0	14.0	13.8	2.525	5.87	1.628
15	57.1	3257	16.8	—	14.7	3.184	4.65	1.450
16	50.8	2583	18.9	17.3	16.4	4.016	3.69	1.291
17	45.3	2048	21.2	—	18.1	5.064	2.93	1.150
18	40.3	1624	23.6	21.2	19.8	6.385	2.32	1.024
19	35.9	1288	26.4	—	21.8	8.051	1.84	.912

9 **Hands-on Electronics** FactCard

CMOS NOR Gates: 4000, 4001, 4002, 4025

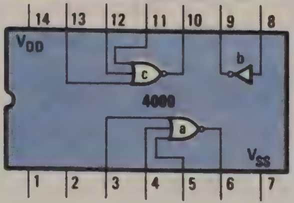
STATIC ELECTRICAL CHARACTERISTICS

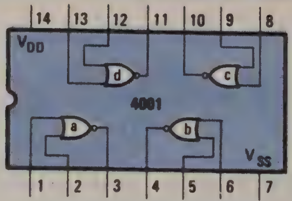
CHARACTERISTIC (25°C)	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.01	µA
	—	0,10	10	0.01	
	—	0,15	15	0.01	
	—	0,20	20	0.02	
Output Low (Sink)Current I_{OL} Min.	0.4	0,5	5	1	mA
	0.5	0,10	10	2.6	
	1.5	0,15	15	6.8	
Output High (Source) Current I_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.		0.18	18	$\pm 10^{-5}$	µA

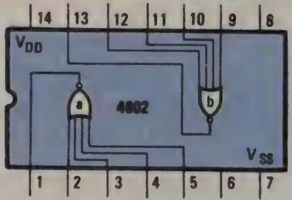
CHARACTERISTIC (25°C)	CONDITIONS			Typ.	UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)		
Output Voltage Low-Level V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	1.5	V
	1,9	—	10	3	
	1.5,13.5	—	15	4	
Input High Voltage V_{IH} Min.	0.5	—	5	3.5	
	1	—	10	7	
	1.5	—	15	11	

9 Hands-on Electronics FactCard

CMOS NOR Gates: 4000, 4001, 4002, 4025



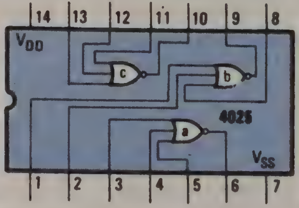




MAXIMUM RATINGS

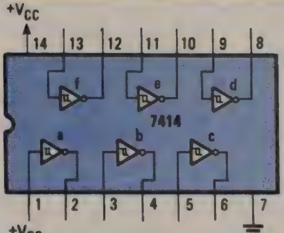
(Absolute-Maximum Values)

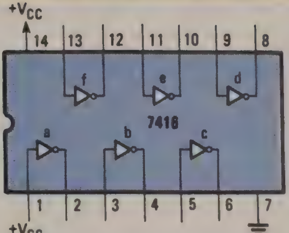
DC SUPPLY-VOLTAGE RANGE, (V_{DD}) (Voltages referenced to V_{SS} Terminal)	−0.5 to +20V
INPUT VOLTAGE RANGE, ALL INPUTS	−0.5 TO V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT	±10 mA
POWER DISSIPATION	
For T_A = −40 to +60°C	500 mW
For T_A = +60 to +85°C	Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR T_A = FULL PACKAGE TEMPERATURE RANGE (All Package Types)	100 mW
OPERATING TEMPERATURE RANGE (T_A)	−40 to +85°C
STORAGE TEMPERATURE RANGE (T_{STG})	−65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING)	+265°C

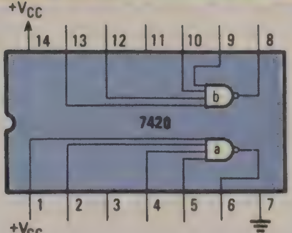


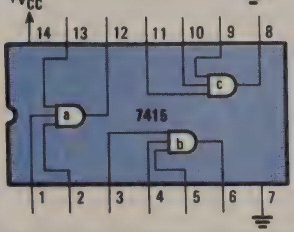
8 Hands-on Electronics **FactCard**

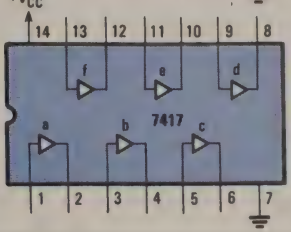
TTL Gates: 7414, 7415, 7416 7417, 7420, 7421

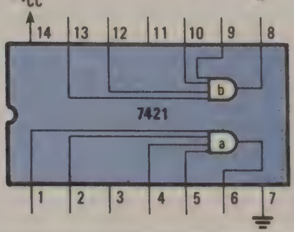








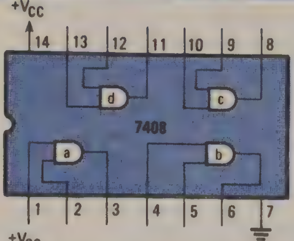


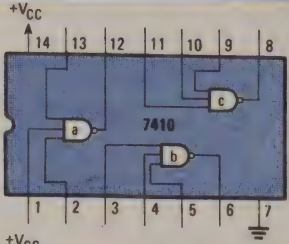


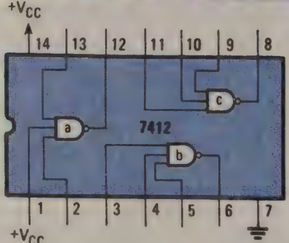
8

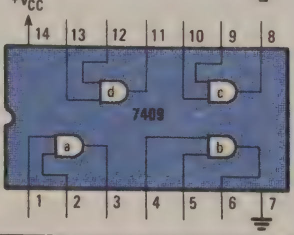
Hands-on Electronics **FactCard**

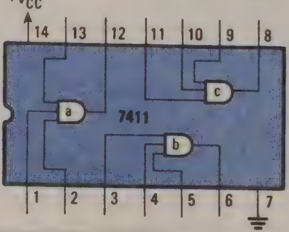
TTL Gates: 7408, 7409, 7410 7411, 7412, 7413

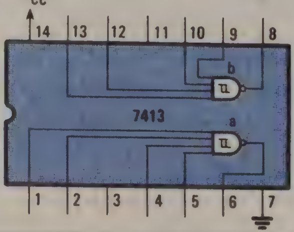












7 Hands-on Electronics FactCard Computer Communications

RS-232C SERIAL INTERFACE

Pin	Signal	
	Synchronous	**Asynchronous**
1	Frame ground	Frame ground
2	Transmit data	Transmit data
3	Receive data	Receive data
4	Request to send	Request to send
5	Clear to send	Clear to send
6	Data set ready	Data set ready
7	Signal ground	Signal ground
8	Carrier detect	Carrier detect
9	—	+12V
10	—	−12V
15	Transmit clock	
17	Receive clock	
20	Data terminal ready	Data terminal ready
22	Ring indicator	Ring indicator
24	External transmit clock	

CENTRONICS PARALLEL INTERFACE

Pin	Signal	Pin	Signal
1	Data strobe	2	Twisted pair ground (data strobe)
3	Data bit 1	4	Twisted pair ground (data bit 1)
5	Data bit 2	6	Twisted pair ground (data bit 2)
7	Data bit 3	8	Twisted pair ground (data bit 3)
9	Data bit 4	10	Twisted pair ground (data bit 4)
11	Data bit 5	12	Twisted pair ground (data bit 5)
13	Data bit 6	14	Twisted pair ground (data bit 6)
15	Data bit 7	16	Twisted pair ground (data bit 7)
17	Data bit 8	18	Twisted pair ground (data bit 8)
19	$\overline{\text{ACKNOWLEDGE}}$	20	Twisted pair ground ($\overline{\text{ACKNOWLEDGE}}$)
21	Busy	22	Twisted pair ground (busy)
23	Logic 0 (ground)	24	Twisted pair ground (demand)
25	On-line	26	Not used
27	Signal ground	28	Logic 1
29	Not used	30	Ground
31	Signal ground	32	To pin 34
33	Chassis ground	34	Printer connected
35	+5 V	36	Demand
37	+17 V	38	Not used
39	+17 V	40	Not used

7 Hands-on Electronics FactCard ASCII Table

HEX CODE	CHAR	HEX CODE	CHAR	HEX CODE	CHAR	HEX CODE	CHAR	HEX CODE	CHAR	HEX CODE	CHAR
00	NUL	16	SYN	2C	,	42	B	58	X	6E	n
01	SOH	17	ETB	2D	—	43	C	59	Y	6F	o
02	STX	18	CAN	2E	.	44	D	5A	Z	70	p
03	ETX	19	EM	2F	/	45	E	5B	[	71	q
04	EOT	1A	SUB	30	0	46	F	5C	\	72	r
05	ENQ	1B	ESC	31	1	47	G	5D	]	73	s
06	ACK	1C	FS	32	2	48	H	5E	∧	74	t
07	BEL	1D	GS	33	3	49	I	5F	←	75	u
08	BS	1E	RS	34	4	4A	J	60	'	76	v
09	HT	1F	VS	35	5	4B	K	61	a	77	w
0A	LF	20	SP	36	6	4C	L	62	b	78	x
0B	VT	21	!	37	7	4D	M	63	c	79	y
0C	FF	22	"	38	8	4E	N	64	d	7A	z
0D	CR	23	#	39	9	4F	O	65	e	7B	>
0E	SO	24	$	3A	:	50	P	66	f	7C	¦
0F	SI	25	%	3B	;	51	Q	67	g	7D	≥
10	DLE	26	&	3C	<	52	R	68	h	7E	~
11	DC1	27	'	3D	=	53	S	69	i	7F	DEL
12	DC2	28	(	3E	>	54	T	6A	j		
13	DC3	29	)	3F	?	55	U	6B	k		
14	DC4	2A	*	40	@	56	V	6C	l		
15	NAK	2B	+	41	A	57	W	6D	m		

6

Hands-on Electronics

FactCard Timer IC's: 555

555
ELECTRICAL CHARACTERISTICS

Parameter	Test Conditions	Value			Units
		Min	Typ	Max	
Supply Voltage		4.5		16	V
Supply Current[1]	$V_{CC} = 15V\ R_L = \infty$		10	15	mA
Threshold Voltage			⅔		× V_{CC}
Trigger Voltage	$V_{CC} = 15V$		5		V
Trigger Current			0.5		µA
Reset Voltage		0.4	0.7	1.0	V
Reset Current			0.1		mA
Threshold Current	Note 2		0.1	.25	µA
Control Voltage Level	$V_{CC} = 15V$	9.0	10	11	V
Output Voltage (low)	$V_{CC} = 15V\quad I_{SINK} = 10mA$		0.1	.25	V
Output Voltage Drop (low)	$V_{CC} = 15V$ $I_{SOURCE} = 200mA$		12.5		V

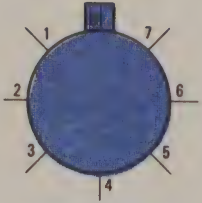
NOTES

1. Low State; Supply Current when output high is typically 1mA lower.
2. This will determine the maximum value of $R_{tA} + R_{tB}$.

$T_A = 25°C$, $V_{CC} = +5$ to $+15$ unless otherwise specified

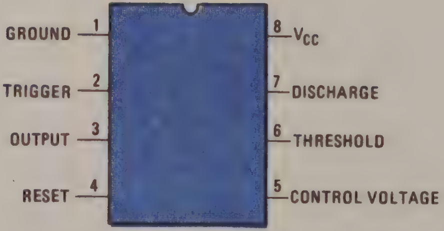
6 Hands-on Electronics FactCard Timer IC's: 555

555



1. GROUND
2. TRIGGER
3. OUTPUT
4. RESET
5. CONTROL VOLTAGE
6. THRESHOLD
7. DISCHARGE
8. V_{CC}

TO5



DIP

5 Hands-on Electronics FactCard

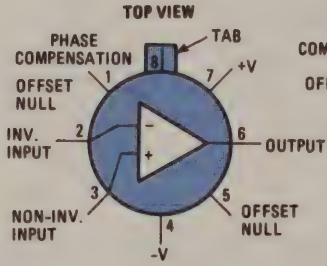
Op Amps: 101

101
ELECTRICAL CHARACTERISTICS

PARAMETER	VALUE	UNITS
Input Offset Voltage	1.0	mV
Input Offset Current	40	nA
Input Bias Current	120	nA
Input Impedance	0.8	mΩ
Input Voltage Range	±13	V
Common Mode Rejection Ratio	90	dB
Voltage Gain	160,000	—
Output Voltage Swing	±14	V
Temperature Range	−55 to +125	°C
Temperature Drift	3.0	μV/°C
Supply Voltage Range	±5 to ±20	V
Power Consumption	50	mV
Power-Supply Rejection Ratio	90	dB

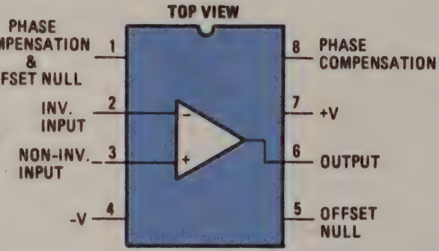
5 Hands-on Electronics FactCard Op Amps: 101

101



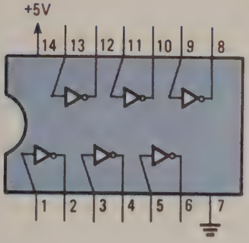
NOTE: PIN 4 IS CONNECTED TO CASE

TO5

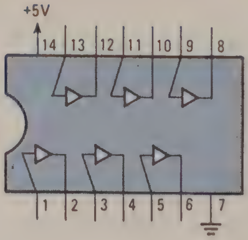


DIP

4 | Hands-on Electronics FactCard | Digital IC's: 7406, 7407

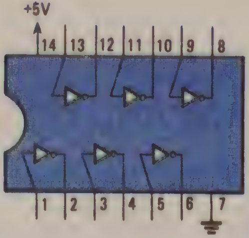


7406
HEX BUFFER/DRIVER
(INVERTING; OPEN-COLLECTOR, HIGH-VOLTAGE OUTPUT)

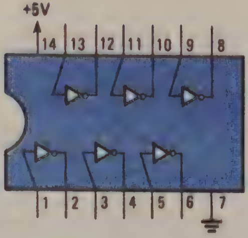


7407
HEX BUFFER/DRIVER
(NON-INVERTING; OPEN COLLECTOR, HIGH-VOLTAGE OUTPUT)

Digital IC's: 7404, 7405



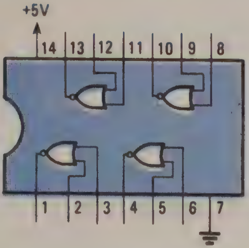
7404
HEX INVERTER



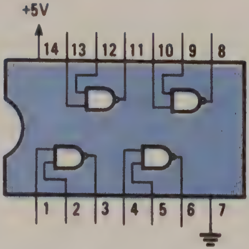
7405
HEX INVERTER
(OPEN COLLECTOR)

3 Hands-on Electronics FactCard

Digital IC's: 7402, 7403



7402
QUAD 2-INPUT
NOR GATE



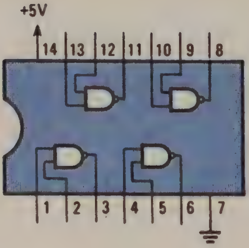
7403
QUAD 2-INPUT
NAND GATE
(OPEN COLLECTOR)

3

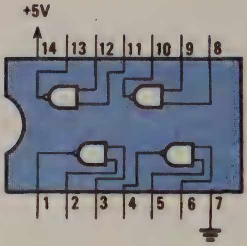
Hands-on Electronics

FactCard

Digital IC's: 7400, 7401



**7400
QUAD 2-INPUT
NAND GATE**



**7401
QUAD 2-INPUT
NAND GATE
(OPEN COLLECTOR
OUTPUT)**

2 Hands-on Electronics FactCard Op Amps: 741

741
ELECTRICAL CHARACTERISTICS

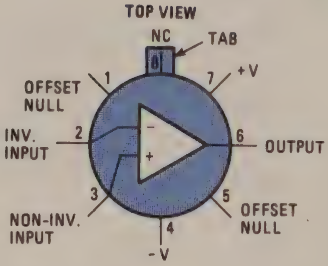
PARAMETER	VALUE*	UNITS
Input Offset Voltage	1	mV
Input Offset Current	20	nA
Input Bias Current	80	nA
Input Impedance	2	mΩ
Input Common-Mode Range	±13	V
Common Mode Rejection Ratio	90	dB
Voltage Gain**	200,000	—
Output Voltage Swing		V
R_L = 10KΩ	±14	V
R_L = 2KΩ	±13	
Power Consumption	50	mV
Power-Supply Rejection Ratio	30	dB

V_{CC} = ±15V; T_A = 25°C

*typical
**open loop

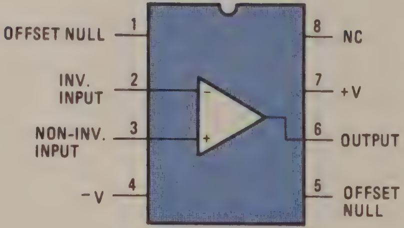
2 Hands-on Electronics FactCard Op Amps: 741

741



NOTE: PIN 4 IS CONNECTED TO CASE

TO5



DIP

1 Hands-on Electronics FactCard Discrete Components

RESISTORS

STANDARD ¼ WATT RESISTANCE VALUES, 5% TOLERANCE

2.2
2.4
2.7
3.0
3.3
3.6
3.9
4.3
4.7
5.1
5.6
6.2
6.8
7.5
8.1
9.1
10

11
12
13
15
16
18
20
22
24
27
30
33
36
39
43
47

51
56
62
68
75
82
91
100
110
120
130
150
160
180
200
220

240
270
300
330
360
390
430
470
510
560
620
680
750
820
910
1.0K

1.1K
1.2K
1.3K
1.5K
1.6K
1.8K
2.0K
2.2K
2.4K
2.7K
3.0K
3.3K
3.6K
3.9K
4.3K
4.7K

5.1K
5.6K
6.2K
6.8K
7.5K
8.2K
9.1K
10K
11K
12K
13K
15K
16K
18K
20K
22K

24K
27K
30K
33K
36K
39K
43K
47K
51K
56K
62K
68K
75K
82K
91K
100K

110K
120K
130K
150K
160K
180K
200K
220K
240K
270K
300K
330K
360K
390K
430K
470K

510K
560K
620K
680K
750K
820K
910K
1.0M
1.1M
1.2M
1.3M
1.5M
1.6M
1.8M
2.0M
2.2M

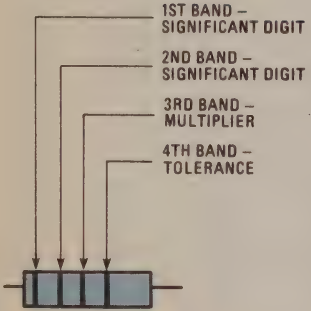
2.4M
2.7M
3.0M
3.3M
3.6M
3.9M
4.3M
4.7M
5.1M
5.6M
6.2M
6.8M
7.5M
8.2M
9.1M
10M

All values in ohms

1 Hands-on Electronics FactCard

Discrete Components

RESISTOR COLOR CODE



Color	Meaning		
	Significant digit	Multiplier	Tolerance (%)
Black	0	1	—
Brown	1	10	—
Red	2	100	—
Orange	3	1K	—
Yellow	4	10K	—
Green	5	100K	—
Blue	6	—	—
Violet	7	—	—
Gray	8	—	—
White	9	—	—
Silver	—	0.01	10%
Gold	—	0.1	5%
No Band	—	—	20%

10 Electronics NOW FactCard

Wire Table

COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear Inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
1	289.3	83690	—	—	—	.1239	119.6	7.348
2	257.6	66370	—	—	—	.1563	94.8	6.544
3	229.4	52640	—	—	—	.1970	75.2	5.827
4	204.3	41740	—	—	—	.2485	59.6	5.189
5	181.9	33100	—	—	—	.3133	47.3	4.621
6	162.0	26250	—	—	—	.3951	37.5	4.115
7	144.3	20820	—	—	—	.4982	29.7	3.665
8	128.5	16510	7.6	—	7.1	.6282	23.6	3.264
9	114.4	13090	8.6	—	7.8	.7921	18.7	2.906
10	101.9	10380	9.6	9.1	8.9	.9989	14.8	2.588
11	90.7	8234	10.7	—	9.8	1.26	11.8	2.305
12	80.8	6530	12.0	11.3	10.9	1.588	9.33	2.053
13	72.0	5178	13.5	—	12.8	2.003	7.40	1.828
14	64.1	4107	15.0	14.0	13.8	2.525	5.87	1.628
15	57.1	3257	16.8	—	14.7	3.184	4.65	1.450
16	50.8	2583	18.9	17.3	16.4	4.016	3.69	1.291
17	45.3	2048	21.2	—	18.1	5.064	2.93	1.150
18	40.3	1624	23.6	21.2	19.8	6.385	2.32	1.024
19	35.9	1288	26.4	—	21.8	8.051	1.84	.912

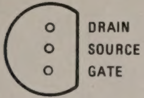
10 **Electronics NOW** FactCard

Wire Table

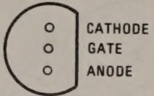
COPPER-WIRE TABLE

Wire Size A.W.G. (B&S)	Diam. in Mils	Circular Mil Area	Turns per Linear Inch (25.4 mm)			Ohms per 1000 ft. 20°C	Current Carrying Capacity at 700 C.M. per Amp	Diam. in mm.
			Enamel	S.C.E.	D.C.C.			
20	32.0	1022	29.4	25.8	23.8	10.15	1.46	.812
21	28.5	810	33.1	—	26.0	12.8	1.16	.723
22	25.3	642	37.0	31.3	30.0	16.14	.918	.644
23	22.6	510	41.3	—	37.6	20.36	.728	.573
24	20.1	404	46.3	37.6	35.6	25.67	.577	.511
25	17.9	320	51.7	—	38.6	32.37	.458	.455
26	15.9	254	58.0	46.1	41.8	40.81	.363	.405
27	14.2	202	64.9	—	45.0	51.47	.288	.361
28	12.6	160	72.7	54.6	48.5	64.9	.228	.321
29	11.3	127	81.6	—	51.8	81.83	.181	.286
30	10.0	101	90.5	64.1	55.5	103.2	.144	.255
31	8.9	80	101	—	59.2	130.1	.114	.227
32	8.0	63	113	74.1	61.6	164.1	.090	.202
33	7.1	50	127	—	66.3	206.9	.072	.180
34	6.3	40	143	86.2	70.0	260.9	.057	.160
35	5.6	32	158	—	73.5	329.0	.045	.143
36	5.0	25	175	103.1	77.0	414.8	.036	.127
37	4.5	20	198	—	80.3	523.1	.028	.113
38	4.0	16	224	116.3	83.6	659.6	.022	.101
39	3.5	12	248	—	86.6	831.8	.018	.090

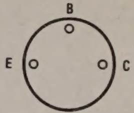
19 Electronics NOW FactCard Transistor Pinouts



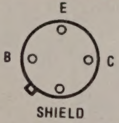
TO-92c



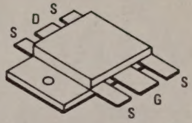
TO-92f



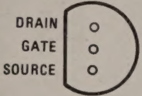
TO-106



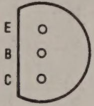
SO-12a



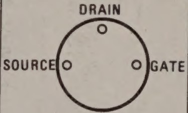
C220



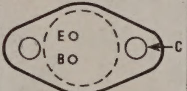
TO-92d



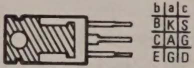
TO-92h



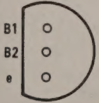
TO-106f



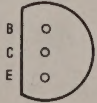
SO-55



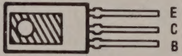
P1
(ALSO PLASTIC TO-66)



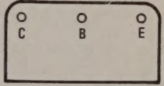
TO-92e



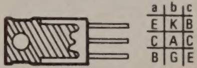
TO-98



TO-126

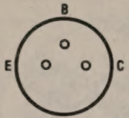


E-LINE

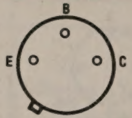


P3
(ALSO PLASTIC TO-3)

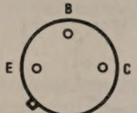
19 Electronics NOW FactCard Transistor Pinouts



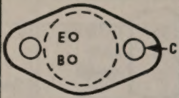
TO-1a



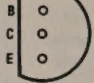
TO-5



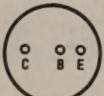
TO-18



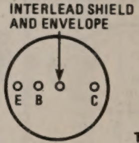
TO-66



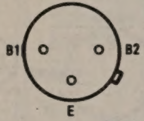
TO-92



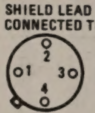
TO-1b



TO-7

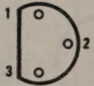


TO-18a



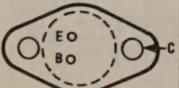
	-	g
1	e	d
2	b	s
3	c	g
4	sh	sh

TO-72

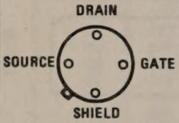


	a	k
1	E	B
2	B	E
3	C	C

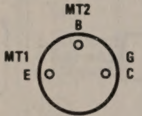
TO-92a



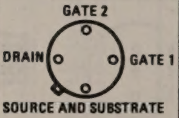
TO-3



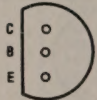
TO-12



TO-39



TO-72f



TO-92b